ALPHABET OF BOTANY.

A New Edition

BY

JAMES RENNIE, M.A.

PRICE HALF-A-CROWN.

ALPHABET OF BOTANY,

FOR

THE USE OF BEGINNERS.

BY JAMES RENNIE, M.A.,

PROFESSOR OF ZOOLOGY, KING'S COLLEGE, LONDON.

A New Edition,

REVISED, WITH NUMEROUS ADDITIONS.

REV. JOHN RAY, M.A., F.R.S.

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PLAN OF THE WORK.

If it may be considered of some little moment, in this world of care, to multiply the sources of human enjoyment, the study of Botany, independently of any other circumstance, ought to stand high in the estimation of those who have more leisure than they know well how to get rid of. So long as every plant that intrudes itself unbidden into the garden or the corn field is stigmatised as a weed, and every flower that may blow by the way side, though it beautify the hedge bank or the green lane, or though, in the fine poetical language of Scripture, it cause "the wilderness and the solitary place to be glad, and the desert to rejoice and blossom as the rose"—so long, I say, as such are passed unheeded by those who walk abroad in the fields, they might almost as well be previously blindfolded, since they must overlook many thousand beauties, which the Botanist everywhere discovers, and must lose more than half the pleasure they might otherwise enjoy

I was about fifteen when I took my first botanical ramble with Withering's British Plants under my arm, and the fresh enthusiasm of youth to spur me onward in the path of knowledge. The day, I recollect, was one of the loveliest in what Coleridge so expressively calls "the leafy month of June;" and I soon found a spot on the banks of the Ayr, where there were more flowers than it was possible for a mere beginner to master, even with a long summer's day at his command. I was delighted, however, to make out, by the aid of my book, the pretty bright blue flowered germander speedwell, and one or two more plants of easy discovery, which I happily met with; and from that day to the present moment, when I am just returned from botanising in the place so splendidly described by Lord Byron, where,

> " The castell'd crag of Drachenfels
> Frowns o'er the wide and winding Rhine,"—
> CHILDE HAROLD.

I have never felt more simple and unalloyed pleasure than in the study of Botany.

By widening the field of thought, if such an expression be allowable, this study adds much to the pleasures of a traveller, even when wandering among the sublimest scenery of Nature; and though Akenside, in a fine burst of poetry, exclaims,—

> " Who, that, from Alpine heights, his labouring eye
> Shoots round the wide horizon, to survey
> Nilus or Ganges rolling his bright wave
> Through mountains, plains, through empires black with shade,
> And continents of sand, will turn his gaze
> To mark the windings of a scanty rill
> That murmurs at his feet?"
> PLEASURES OF IMAGINATION.

yet this does not agree with my own experience; for while on our British "Alpine heights," when admiring, as I have done, a glorious sunset from the top of Skiddaw, and while watching the thick mustering of thunder-clouds from the summit of Snowdon; and no less in Switzerland, when viewing, as I have done, the unclouded majesty of Mont Blanc in the bright sunshine of summer, from the lofty ridge of the Col de Balm,—I have always found my thoughts expanded rather than narrowed; my fancy elevated rather than brought low, by turning, from the magnificence and grandeur around me, to the minute plants growing and blooming at my feet. In all such circumstances, while studying the look, the aspect, the countenance of things, as I may call it, from the tiniest moss, or the smallest flower, up to the mountain range and the expanded firmament, the interpretation thereof has rushed irresistibly into my mind,—

"The hand that made us is DIVINE."—ADDISON.

The following little book, then, is intended to assist beginners, who commence, as I myself did, without any instructor, and who may find, as I did, that all the ordinary books, purporting to be elementary introductions, are written on the principle of the student knowing a great deal before he begins; or rather of the authors being seemingly afraid of vulgarising their science by making it too plain. Having no fear of this kind, but rather that of not being plain enough, I shall never be deterred from resorting to the plainest and most homely language, in order to be as intelligible as possible.

The chief feature, however, that distinguishes the present little book is, that it is not confined to the mere exposition of a system. Most of the elementary works on Botany are limited to illustrations of the Linnæan System, and a few comprehend also the Jussieuan System; but whilst I have introduced outlines of both these systems, I have, at the same time, placed more prominently the most important parts of the science connected with Structure, Fructification, and Germination. I have further rejected the modern fanciful nonsense of every part of a plant being only a metamorphosed leaf. (See page 153.)

It has been very injurious to the genuine science of Botany, that it has been recently fashionable to place the names of mere systematic Botanists so much higher than those who study the superior branches of the science, as to cause the latter to be thereby much overlooked and neglected. The great masters of philosophical Botany, whose works I earnestly request the student to peruse, are Grew, Malpighi, Leuwenhoeck, Ray, Micheli, Reichel, Hill, Saussure, Bonnet, Du

Hamel, Hales, Hedwig, Gaertner, Comparetti, Krocker, Mirbel, Link, Rudolphi, Treviranus, Moldenhewer, Kieser, Turpin, Sennebier, Spallanzani, Darwin, Keith, Ellis, Knight, Dutrochet, Amici, Adolphe Brongniart, Girou de Busaraingues, and a few others. It is honourable to our own country to have produced such able observers and experimenters as Grew, Hales, Ellis, and T. A. Knight. I leave it to others to give a similar list of the Systematists, who can never stand in a higher rank than mere pioneers, whose labours are indispensably necessary to the philosopher in the higher departments of the science.

Bonn on the Rhine,
July 20th, 1832.

NOTICE TO THE SECOND EDITION.

A large impression of the first edition having been all sold off in the short period of six months, no pains have been spared to improve the work by careful revision and very numerous additions. For these, I have been chiefly indebted to Link's Elementa, De Candolle's Physiologie Vegetale, the Annales des Sciences Naturelles, and Von Martius's Genera Palmarum.

Lee, Kent, August 1st, 1833.

ALPHABET OF BOTANY.

THE WORD PLANT.

It will be useful, on commencing the study of which this little book treats, to mention some of the points that distinguish plants from the other productions of nature.

The word *Plant*[1] means "fixed," or "rooted," and hence any production without this leading characteristic is not a plant, though several distinctions besides this are necessary; for otherwise a dead post, the column of a portico, or a granite rock, might be called a plant, from being fixed or rooted.

In a general sense we say that every tree, shrub, herb, grass, fern, moss, sea-weed, or mushroom, is a plant; and popularly it may be said that a plant consists of a root, a stem, and leaves, though many plants, such as mosses and lichens, want one or all of these parts.

Plants differ from animals in having no common mouth, no common gullet, no stomach for the reception

(1) In Greek βοτανη, from which we take our English word Botany.

and digestion of food, and no intestines. They have besides no heart, and consequently no fluid like blood circulating from a point and returning to the same. It follows that they have no lungs, and consequently do not breathe like animals, though they imbibe and exhale gases.

The movements of animals are all made by means of muscles or fleshy ribands; but plants have none of these, and the only locomotion, therefore, which they possess, consists in the extension of parts—as in the runners of the strawberry, or the rooting branches of the bramble and the banyan tree; or in the death of one bulb or corm, and growth of another, as in the orchis and meadow saffron.

Animals again are all more or less endowed with sensibility by means of nerves; but plants have no nerves, and hence, in all probability, no feeling similar to animal sensations. The appearances supposed to indicate feeling in plants I shall afterwards notice.

Dr. Virey remarks that the organs of reproduction in animals are permanent; in plants the organs of reproduction are renewed and fall off every year.

Much ingenuity has been superfluously wasted in discussions to determine whether certain productions, such as the sponge and the freshwater polypus, are plants or animals. It would be equally wise, as it appears to me, for a chemist to set about determining whether Epsom salts is an acid or an alkali; for a sponge and other similar productions may be neither animal nor vegetable, and yet may contain chemical principles from both. The eggs or seeds of some sponges have been observed.

It is contrary to the best established principles of philosophy, also, to maintain with Professor Agardh and M. Unger, that plants, such as the changeable crow-silk, are actually transformed into animals[1].

The following figure contains most of the external parts of a plant.

Bulbous Buttercup (*Ranunculus Bulbosus*).—*a*, root; *b*, bulb; *c*, root leaves; *d*, stem; *e*, stem-leaves; *f*, branches; *g*, flower-stalk; *h*, flowers.

(1) See INSECT TRANSFORMATIONS, chap. vi., where I have discussed this at length.

MEMBERS OF PLANTS.

Under the term member, I shall consider the parts of plants which project from the main body, chiefly with regard to their form, leaving their internal structure to be afterwards noticed. The term *appendage*, often used in modern works, is theoretical and objectionable. With few exceptions plants consist of a part below ground, called the root, and a part above ground, which in the greater number of instances is called the stem.

In describing the members of animals, it is most convenient and natural to begin at the head, but in plants it is usual, and perhaps best, to begin at the root, proceeding from this to the stem and its buds, leaves, branches, and flowers.

ROOTS.

The root[1] of a plant performs the two important offices of retaining it in a fixed position, and supplying it with nourishment, being therefore analogous to the limbs and mouths of animals.

In transplanting trees, it is accordingly found, that the roots are proportional to the branches, spreading widely in trees planted in an open field, but remaining

(1) In Latin, *Radix* or *Axis descendens*.

in a narrow compass in thick woods and forests [1]; and further, that the roots spread much farther on the windward than on the sheltered side of a tree, in order to form a secure hold-fast; while the branches spread least in the windward side. Advantage is taken of this law by the Dutch gardeners, who rear fruit trees in garden-pots, for the roots being thus kept confined, prevent the branches from spreading.

In palms and pines, on the contrary, the lofty stems arise from very short roots; and many slender herbs, such as lucerne and rest harrow, have very long roots.

The perpendicular extent of roots depends greatly on the looseness or compactness of the soil; Du Hamel thence found the root of an oak, sown in a rich deep soil, to be four feet in length, while the stem rose only six inches.

In lichens which encrust rocks, walls, and the bark of trees, I am disposed to consider the whole under surface of the plant as the root, which always clings with more or less firmness to the spot where it grows.

A root usually consists of several parts, the body, the collar or life-knot, the branches or radicles, when such exist, and the rootlets or small fibres which seem to be indispensable in all roots.

The body of the root [2], which is sometimes termed simply the root, varies greatly in form in different species. It may be vertical [3], spindle-shaped [4], conical [5],

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(1) See ALPHABET OF SCIENTIFIC GARDENING, page 31, &c., where illustrative figures are given.

(2) In Latin, *Caudex*.

(3) In Latin, *Perpendicularis*.

(4) In Latin, *Fusiformis*.

(5) In Latin, *Conica*.

turnip-shaped [1], round [2], twin [3], palmate [4], as in peony, digitate [5], abrupt [6], knotted [7], tuberculated [8], bundled [9], jointed [10], contorted [11], fibrous [12], hairy [13], or beaded [14].

Of spindle-shaped roots, the best known is that of the carrot; the most famous in legendary superstition is that of the mandrake, which, however, is not simple, but forked. The abrupt root of a species of scabious is popularly said to have been bitten off by the Devil, a superstition absurdly retained in the terms of scientific works on botany. In popular belief, also, imaginary restorative properties are contained in the twin roots of orchis.

It is worthy of remark, that when the body of a root comes upon a stone, it either divides or goes round it, moulding itself thereupon. I have a specimen of an alder root grown amongst gravel, all over marked with the contour of small stones. On the other hand, when certain roots, such as that of timothy grass, are planted in a moist soil, they are fibrous, but if removed to a dry loose soil, they become tuberculated.

This circumstance corroborates the opinion, that the tubers on the roots of potatoes and some other plants,

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(1) In Latin, *Napiformis*. (2) In Latin, *Rotunda*.
(3) In Latin, *Didyma*. (4) In Latin, *Palmata*.
(5) In Latin, *Digitata*.
(6) In Latin, *Abrupta* or *Præmorsa*, which is bad.
(7) In Latin, *Nodosa*.
(8) In Latin, *Tuberculata* or *Granulata*.
(9) In Latin, *Fasciculata*. (10) In Latin, *Articulata*.
(11) In Latin, *Contorta*. (12) In Latin, *Fibrosa*.
(13) In Latin, *Comosa*. (14) In Latin, *Moniliformis*.

are intended to store up nourishment for the young plants of a succeeding season, in a similar manner to the fat stored up in adolescent insects and animals which become torpid in winter. The shrivelling up of the potato, after the young plant has sprouted and grown, proves the same view.

The most essential part of every root is the crown [1], collar, or life-knot, which is the portion of the plant between the stem or leaves and the body of the root. In many plants, such as the primrose, nearly the whole body of the root may be cut away, and still the plant will grow; but though the body of the root is untouched, if the crown only be removed or seriously injured, it will inevitably die. The crown of a carrot cut off during winter, and made to swim in a glass of water in a warm room, will shoot out vigorous leaves.

When the crown of a root is slender, it dries up as the seed ripens, and the plant soon dies. Such plants are termed annuals, as the poppy, and most sorts of grass and corn. But when from soil, climate, or culture, the crown of the root is rendered strong, several annuals are brought to grow two years, and are then called biennials; or for several years, and are then called perennials. Thus the annual mignonette becomes perennial in Egypt, and the marvel of Peru and the castor oil plant, which are annuals in Europe, are perennial in warm countries, as is also the scarlet runner.

The radicles or branches [2] of roots are to the main

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(1) In Latin, *Collum;* in French, *Collet.*

(2) In Latin, *Rami* or diminutively *Ramuli.*

body what the branches are to the stem, originating and growing in a manner precisely similar, and increasing yearly after the first year in thickness, but not in length. A tuft of grass accordingly has in this way been found with its root branches so much thickened as to form almost a solid mass, in cases where the life of the plant has been many years preserved, in consequence of its being regularly nibbled down by sheep and prevented from seeding.

The small fibres or rootlets [1], though an essential part of a plant, may be destroyed in most cases without causing its death, on account of their being readily reproduced so long as the crown is uninjured. It is at the tips indeed of these rootlets that the spongelets are situated, which take up the food of the plant from the soil. To prove this by Sennebier's experiment, plunge a turnip or a radish in water all but its tail where the rootlets grow, and it will soon wither; place the rootlets only in the water, and it will shoot out fresh leaves.

The rootlets, like the leaves of trees that are not evergreen, are produced annually; in some cases dying and falling off like leaves, as in the dahlia; and in others becoming thicker, harder, and forming radicles or root branches, no longer capable of performing the office of rootlets in taking in nourishment, as in most trees.

This view is beautifully corroborated by plants with fibrous roots growing in loose dry sand, in which, in order to procure all the little moisture possible, an

(1) In Latin, *Fibrillæ* or *Radiculæ*.

incalculable number of rootlets grow from the radicles as fine as hairs.

a, fibrous root of grass, *b*, the same, downy from growing in loose sand.

The roots of trees and most other plants, when once formed, do not lengthen, except at the tips, a fact proved by Du Hamel and Mr. T. A. Knight, who tied threads around roots, and found that the spaces between the threads always measured the same. In the orchis group, Professor Lindley proved, by similar experiments, that this does not hold.

The great care which Providence has taken for the preservation of the life of plants, is strikingly manifested in the fact, that any part of a plant which is furnished with pores, or, in other words, which can form buds, leaves, or branches, may be made to shoot out rootlets, by placing it in warm and moist earth. It is on this principle that plants are propagated by cuttings and layers.

It is a singular property of roots, that they seem as anxious to shun the light, as the leaves and young shoots are to turn to it; and hence, when Dutrochet caused a misseltoe seed to germinate on the inside of a window pane, it sent its root inwards towards the apartment; when on the outside of the pane it did the same. Hence it is that hyacinths grow better in water glasses of a dark colour, than in uncoloured ones.

It may be from this inexplicable law, perhaps, that all roots tend more or less towards the centre of the earth; yet Grew, and recently Dutrochet, found that when French beans were placed in a suspended box, with earth above them and holes below to admit light, they sent their roots down through the holes into the light, and not into the earth in the box. Mr. T. A. Knight placed French beans in moistened moss on revolving wheels, and found that both when the wheel was vertical and when it was horizontal, the radicles were directed outwards towards the circumference.

No root, it is said, is of a green colour, which cannot be produced even by exposure to the light; though by this means green branches may be made to spring from roots, and potatoes exposed to light become green, though their rootlets will not.

Besides sucking in nutriment from the soil, roots give off refuse or indigested matter, as may be seen in the case of hyacinths grown in water. This appears to be the chief cause, that plants will not grow well successively in the same soil unless changed by rotation[1].

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(1) This will be explained in the "ALPHABET OF SCIENTIFIC AGRICULTURE," under Rotation of Crops.

TUBERS AND CORMS.

Upon the same principle which leads naturalists to rank the whale and the dolphin among land animals, and not among fishes, modern botanists do not consider carrots, potatoes, and the like, as roots, but as subterranean stems, because they perform the functions of stems rather than of roots.

There are three sorts of these subterranean or root stems, the tuber, as in the potato and arrow root; the corm [1], as in crocus, meadow saffron, and cuckoo pint erroneously termed a bulb, as it has no scales; and the creeping root stem[2], as in couch grass.

The rootlike claspers emitted from the stems of ivy and some other plants, are not roots, as is erroneously stated by Professor Lindley.

BULBS.

An instance of rootlets falling off like leaves occurs in those arising from bulbs, such as the lily, the tulip, and onion, which perish and fall off, or rather they are pushed off, as is the case with leaves, by buds containing the rudiments of the rootlets destined to be evolved the succeeding season. These root buds are scarcely observable in autumn, but after Christmas they become very distinct.

The crown of the root, in such cases, is the thin circular plate at the base of the bulb, and not the bulb

(1) In Latin, *Cormus* or *Lecus*. (2) In Latin, *Soboles*.

itself, as might at first sight be supposed. Bulbs indeed, have often, by inaccurate writers, been mistaken for a species of roots, though these are never scaly.

The bulb[1], is very similar to, if not identical with what is termed a bud, when found on a stem or branch, and is formed by the base of the leaves becoming thick, and storing up a quantity of nourishment within them for future use. These base-leaves take the form of concentric plates[2], as in the onion, or scales placed somewhat like tiles[3], as in the lilies. In the daffodil, the snowdrop, and hyacinth, the plates of the bulb may be seen in the spring to expand into leaves, and the flower-stalk, previously short and minute, to rise up with the flower-buds at the summit.

Bulbous Roots cut asunder.—*a*, tulip; *b*, lily; *c*, onion.

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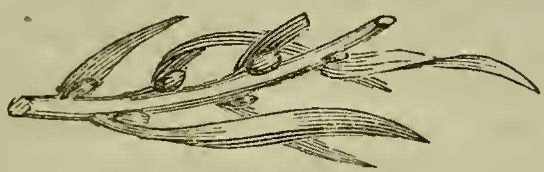
(1) In Latin, *Bulbus*. (2) In Latin, *Tunicatus*.
(3) In Latin, *Imbricatus*.

In bulbous plants, such as the hyacinth and tulip, small bulbs[1] are formed on the edges of the crown of the root between the scales, which gradually enlarge at the expense of the scales, are detached, become perfect bulbs, and send up leaves and flower-stalks.

At the inner base of the stalk leaves, in some other bulbous plants, as in the tiger lily, and in the flower itself, as in the tree onion, small bulbs[2] grow, which on being thrown off and planted, produce perfect plants.



Stem bulbs of the tiger lily.

I am disposed to agree with M. Richard, in considering the small bodies[3], improperly called seeds, in ferns, mosses, and lichens, as similar to the small stem bulbs of the tiger lily, inasmuch as they do not contain a complete embryo, as seeds always do.

STEMS.

As the root and its modifications are, with rare exceptions, always under ground, so the stem[4] is, with

(1) Popularly, *Cloves;* In Latin, *Adnata.*
(2) In Latin, *Bulbuli;* or *Soboles;* or *Propagines.*
(3) In Latin, *Sporulæ.*
(4) In Latin, *Caudex,* or *Axis ascendens.*

similar exceptions, as in the rootstock [1], of the iris, always above ground. Accurately speaking, then, there can be no stemless [2] plant, though there may be leaves arising from the collar of the root, which is in that case the stem, as in the star thistle, in which there is no apparent trunk or bole; and hence it is, in a popular sense, stemless.

The stem [3] is divided from the root by the crown or collar already described, which, though evident in all herbs and on young trees, cannot be recognised in trees of several years' growth. The space between the collar and the first leaf or bud, is termed the bole [4], which is also applied to the space between two or more leaves or buds, whose base is called a node [5], by gardeners an *eye*. The great body of a stem, whether divided into boles or not, is termed the trunk [6].

The stem of grasses, corn, and reeds, is termed the straw [7]; the stem of palms, ferns, mushrooms, and sea weeds, is termed the stalk [8]; the stem of such flowers as the primrose, the daisy, the snowdrop, and the lilies, is termed a *scape* [9], though flower-stalk is certainly better; the running stem, as in the strawberry and cinquefoil, is termed a runner [10]; a shorter runner, that does not root, as in houseleek, is termed an offset [11]; a longer one that does not root, as in the

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(1) In Latin, *Rhizoma*.
(2) In Latin, *Acaulis*.
(3) In Latin, *Caulis*.
(4) In Latin, *Internodium*.
(5) In Latin, *Nodus*.
(6) In Latin, *Truncus*.
(7) In Latin, *Culmus*.
(8) In Latin, *Stipes*.
(9) In Latin, *Scapus*.
(10) In Latin, *Sarmentum*.
(11) In Latin, *Propagulum*.

cucumber, a vinelet[1]; and a small stem proceeding laterally from a root or stool, a sucker[2].

When a trunk bears permanent or perennial branches, the plant is termed a tree[3]; when permanent branches arise, not from a trunk, but from the root, the plant is termed a shrub[4]; when small and much branched, a copse-shrub[5]; when furnished with woody branches that are not permanent, as in tree mignonette, it is termed an under-shrub[6]; and when the whole stem is not woody, and dies down every year at least as far as the crown of the root, the plant is termed an herb[7]; when a trunk is formed, like the underground stem of iris, of the hardened bases of leaves which have withered and fallen, and is not taper, but all of one thickness, giving off no branches, as in the date and cocoa, the plant is termed a palm[8].

BUDS.

In a popular sense, budding means the expanding of buds in spring, and is applied both to flowers and leaves; but buds[9], instead of being then produced, are usually formed, some early in summer, others in autumn; and are beautifully contrived to preserve the

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(1) In Latin, *Viticula.*
(2) In Latin, *Surculus* and *Stolo.*
(3) In Latin, *Arbor;* In Greek, Δενδρον.
(4) In Latin, *Frutex* or *Arbustum.*
(5) In Latin, *Dumus.* (6) In Latin, *Subfrutex.*
(7) In Latin, *Herba,* whence *Herbaceus.*
(8) In Latin, *Palma.* (9) In Latin, *Gemmæ.*

leaves and flowers from the cold of winter. Hence there are no buds (because they are not wanted) in the plants of warm climates, and in our hot-houses; that is, the embryo leaves at the base of the full grown ones, have no bud scales[1], a circumstance which holds also in alder-buckthorn, and in most herbs. Buds are indeed in most respects like bulbs.

Buds have various forms, but are most usually oval or roundish, composed on the outside of tough, somewhat leathery scales, closely tiled, frequently covered with a gummy resin, and internally kept warm by a thick downy substance between the several tender scales or leaves.

Theoretical writers of the present day represent the scales of buds as *abortive* or *imperfect* leaves, leaf-scales, or leaf-stalks; but in creation there is nothing imperfect, and the scales of buds are as perfect and as beautifully contrived as any leaf or flower.

The covering or winter case[2] of a bud, including both the outer hard scales and several inner ones soft and downy, is only a temporary protection, by keeping out water and keeping in warmth, for the central part[3], and for the most part fall off when the latter enlarges in growth.

The central part of a bud may either contain embryo leaves, or embryo flowers. When it contains leaves only[4], it lengthens upwards as it expands into a branch,

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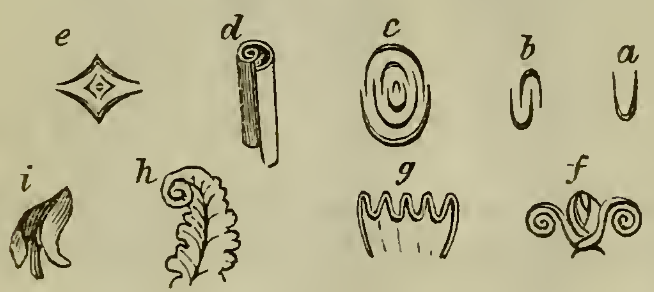
(1) In Latin, *Tegmenta*. (2) In Latin, *Hybernaculum*.
(3) In Latin, *Embryo*, objectionably *Germen*.
(4) In Latin, *Gemma folifera*.

hence there is no real difference between a leaf-bud and a branch-bud[1]. When it contains a flower[2], this is situated as in the bulb of the tulip above figured.

When it contains leaves only, the arrangement of these in folds or otherwise[3], varies much in different groups of plants. It may be plaited[4], as in the birch; doubled[5], as in the rose and the oak; tiled[6], as in the lilac and privet; embracing[7], as in the iris and the sage; rolled lengthways[8]; rolled inwards[9]; rolled outwards[10]; rolled from the tip to the base[11]; or wrapt round the leaf-stalk[12].



Modes in which the leaves in buds are folded.—*a*, doubled, *oak*, *rose*, &c.; *b*, doubled embracing, *valerian*, *teasel*, &c.; *c*, doubled-compound, *mimosa*, *carrot*, &c.; *d*, rolled inwards, *grasses*, &c.; *e*, tiled, *privet*, *lilac*, &c.; *f*, rolled outwards, *rosemary*, *primrose*, &c.; *g*, plaited, *palms*, *birch*, &c.; *h*, rolled breadth-wise, *ferns*; *i*, reclining, *wolf's-bane*, *anemone*, &c.

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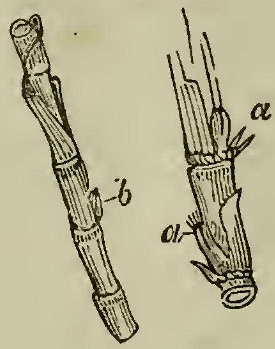
(1) In Latin, *Gemma ramifera*.
(2) In Latin, *Gemma florifera*.
(3) In Latin, *Foliatio* or *Vernatio*. (4) In Latin, *Plicata*.
(5) In Latin, *Conduplex*. (6) In Latin, *Imbricata*.
(7) In Latin, *Equitans*.
(8) In Latin, *Convoluta*. (9) In Latin, *Involuta*.
(10) In Latin, *Revoluta*. (11) In Latin, *Circinalis*.
(12) In Latin, *Reclinata*.

Turpin says the buds of grasses and plants of the same class, are always distinguished by an outer single scale between the stem and the bud; while plants of another class have two scales on opposite sides, either distinct or united.



Grass Buds.—*a*, *a*, covered by the scales; *b*, the scales removed.

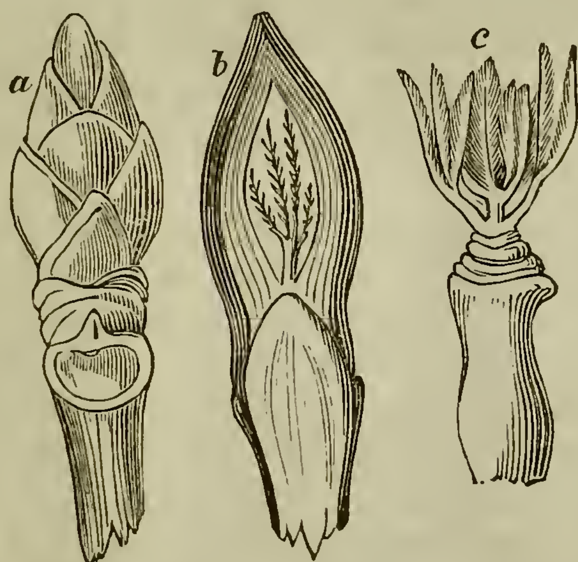
A leaf-bud is always more slender and pointed than a flower-bud, and when it expands, it lengthens upwards.

When the buds contain flowers again, they are more or less bulged out and blunt at the point, and hence gardeners discover the prospect of blooming long before summer. They do not, upon expanding, lengthen upwards like a leaf-bud. As in the case of leaf-buds, the embryo flower is disposed in various forms[1] within its envelope, both as to the petals of the blossom, and as to the cup or calyx, though these two are often arranged differently in the same flower. It may be

(1) In Latin, *Æstivatio*.

tiled[1], as in the rose and the cherry; plaited[2], as in the potato; rolled up into a spiral[3], as in the wood-sorrel; rumpled[4], as in the poppy; five-fold[5], as in the pink; or valved[6], as in ginseng.

Very beautiful details have been given by Malpighi of the bud of the oak, and by Du Hamel of the bud of the horse-chestnut.



Three stages in the growth of a horse-chestnut leaf-bud.—*a*, full grown bud; *b*, the same bud further advanced, in which the young leaves are seen expanding, but still inclosed by the bud-scales; *c*, the young leaves after the bud has partially opened, the bud-scales removed.

Buds are usually found at the inner base[7] of leaves; but sometimes they occur on the edge of a leaf, as in

(1) In Latin, *Imbricata.*
(2) In Latin, *Plicata.* (3) In Latin, *Contorta* or *Torsiva.*
(4) In Latin, *Corrugata.* (5) In Latin, *Quincuncialis.*
(6) In Latin, *Valvaris.* (7) In Latin, *Axilla.*

marsh twayblade; and M. Turpin found them on the surface of the leaf in the star of Bethlehem.

When a tree puts forth very many buds, it is liable to exhaust its strength in nourishing them. In order in some measure to prevent this, Providence has created several birds, such as bullfinches, which devour flower-buds in winter, and many insects which devour them in spring; but it is not true, as has been said that a tree rendered sickly by over production, is most favourable to the hatching of the eggs of such insects; and much less true that bud-eating insects prefer sickly to vigorous buds.

Bonnet arranged buds according as they are placed opposite each other or alternating on opposite sides of a branch; in form of a ring round a branch; or in form of a spiral round a branch. When they are opposite, there are three buds at the top of the branch; when alternate, only one. In pines the buds are only at the summit, and several shoots spring from one bud.

Darwin fancied each bud to be a complete individual plant, and a tree to be an aggregate of buds; because when a bud is cut from one tree and inserted into another, it is found to grow into a perfect branch, a circumstance from which gardeners have derived the ingenious art of budding or bud-grafting. Baron Tschudy has in this way grafted the potato on the love-apple, and the melon on the gourd; and others have grafted fine varieties of the dahlia on more common sorts, by inserting the young buds or eyes[1] into the root.

(1) In Latin, *Oculi.*

LEAVES.

It appears from experiments, that leaves perform some office similar to the lungs of animals; at least, when healthy and exposed to sunshine, that they exhale oxygen gas through the pores on their surface, afterwards described, and at night or in cloudy weather that they exhale carbonic acid gas.

A leaf[1] may be said, with several exceptions, to consist of a leaf-stalk[2], and a leaf-plate, which is the part usually termed the leaf. When the leaf-stalk is wanting, or so short that the base of the leaf touches the branch or stem, it is termed a sitting[3] leaf, as in the poppy. The inner base[4] of the leaf-stalk, where it joins the stem, is the place where buds are formed. The leaf-plate[5], or proper leaf itself, is sometimes wanting, the leaf-stalk only spreading out like a leaf. In such cases, not the surfaces, which are both alike, are presented to earth and sky, but the edges.

The leaf-stalk may be simple, compound, round, flattish[6], channelled[7], winged[8], tendrilled[9], or sheathing[10].

From the upper end of the leaf-stalk a number of

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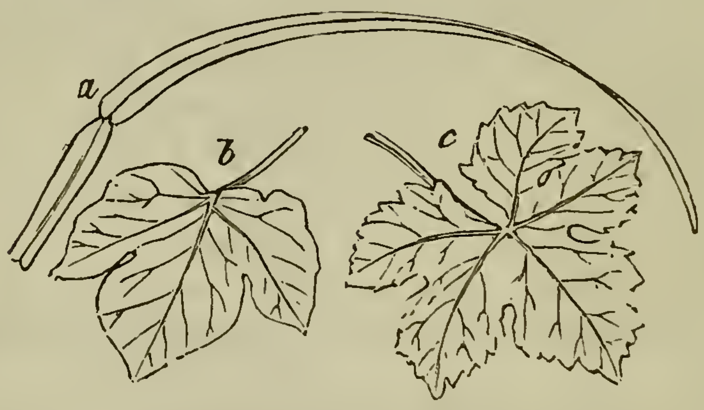
(1) In Latin, *Folium*.
(2) In Latin, *Petiolus*, whence *Petiolatum*.
(3) In Latin, *Sessile*.
(4) In Latin, *Axilla*, whence *Axillaris*.
(5) In Latin, *Lamina*.
(6) In Latin, *Compressus*, which is objectionable.
(7) In Latin, *Canaliculatus*.
(8) In Latin, *Alatus*.
(9) In Latin, *Cirriferus*.
(10) In Latin, *Vaginans*.

branches run through the whole leaf-plate, which have improperly been termed *nerves,* and sometimes *veins,* but which I shall term leaf-ribs [1], and their small branches riblets [2].

The simplest form of leaf-ribs occurs in grasses and other plants, the bases of whose leaves sheath or embrace the stems [3]; and in some other leaves there are, besides the main or mid-rib [4], in the middle of the leaf two nearly as large at each side [5], from which botanists term such leaves three-nerved; and when the large ribs are five, seven, or any other number, they are named accordingly. In the tulip, no branches are observable.



Ribs of Leaves.—*a*, grass leaf, one-ribbed; *b*, ivy leaf, three-ribbed; *c*, grape leaf, five-ribbed.

By following out the branching from the mid-rib, some clue may be obtained to the almost countless array

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(1) In Latin, *Costæ folii.* (2) In Latin, *Costulæ.*
(3) In Latin, *Folia amplexicaulia.* (4) In Latin, *Costa media.*
(5) In Latin, *Costæ laterales.*

of forms of leaves and terms for these which botanists enumerate, presenting to the beginner a wilderness of words, enough to deter him from journeying farther. Dr. Drummond has not, as it appears to me, been happy in his endeavour to simplify this matter, by arraying leaves as named from "parts of the animal body;" from "instruments of war;" from "musical instruments;" from "mechanical bodies;" and from "the heavenly bodies." Professor Lindley, adhering to the objectionable term *vein*, divides leaves into veinless, equal-veined, straight-veined, curve-veined, netted, ribbed, *falsely*-ribbed, radiating, feather-veined, and hidden-veined; most of the corresponding Latin terms which he has invented are quite barbarous; his *falsely* I do not pretend to understand.

I shall follow the expansion of the ribs, according as they are throughout regular, or as one or more pairs of the side branches are more or less long than the others; and again, as these branches are united in a single leaf-plate, termed simple leaves, or divided into several small leaf-plates on the same common leaf-stalk, termed compound leaves.

Simple Leaves.

When the mid-rib and its branches form a simple leaf*, it may be line-like [1], as in juniper; awl-shaped [2], as in the jonquil; spear-shaped [3], as in rib-wort; sword-

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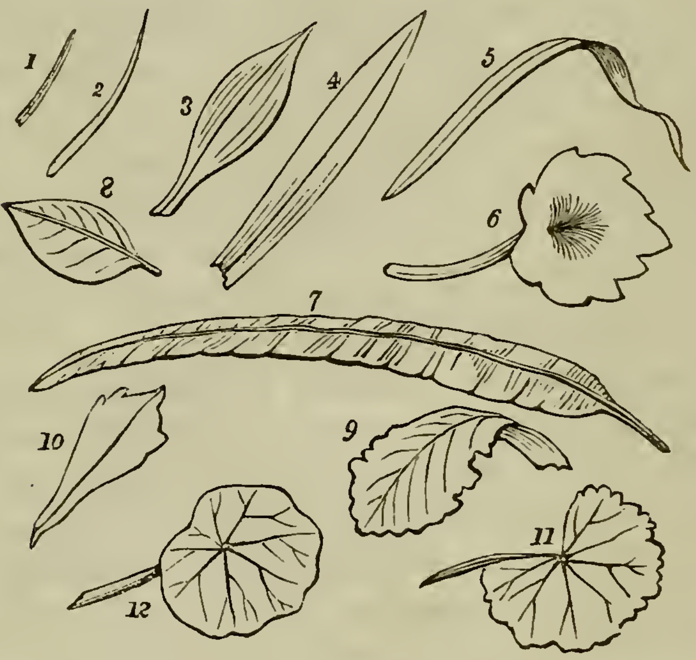
(*) In Latin, *Folium simplex*.
(1) In Latin, *Lineare*.
(2) In Latin, *Subulatum*.
(3) In Latin, *Lanceolatum*.

shaped [4], as in the iris; riband-like [5], as in grass; spoon-shaped [6], as in navel-wort; oblong [7], as in the banana; egg-oblong [8], as in the marjoram; inversely egg-oblong [9], as in the cowslip; wedge-shaped [10], as in shrub-candy tuft; roundish [11], as in round-leaved mallow; or shield-shaped [12], as in the Indian cress or nasturtium.



Simple Leaves.—The reference figure s correspond with those in the text of the preceding paragraph.

When the pair of rib-branches at the base stretch farther than the others, the leaves become halberd-

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(4) In Latin, *Ensiforme*.
(5) In Latin, *Gramineum*.
(6) In Latin, *Spatulatum*.
(7) In Latin, *Oblongum*.
(8) In Latin, *Ovatum*.
(9) In Latin, *Obovatum*.
(10) In Latin, *Cuneiforme*.
(11) In Latin, *Subrotundum*.
(12) In Latin, *Peltatum*.

shaped[1], as in cuckoo-pint; heart-shaped[2], as in burdock; arrow-shaped[3], as in sorrel; kidney-shaped[4], as in ground ivy; triangular[5], as in mercury; three-lobed[6], as in hepatica; four-cornered[7], as in the tulip tree; fiddle-shaped[8], as in fiddle dock; trowel-shaped[9], as in black poplar; or diamond-shaped[10], as in water caltrops.

Simple Leaves.—The reference figures correspond with those in the text of the preceding paragraph.

Again, when more of the rib-branches besides the

(1) In Latin, *Hastatum*.
(2) In Latin, *Cordatum*.
(3) In Latin, *Sagittatum*.
(4) In Latin, *Reniforme*.
(5) In Latin, *Triangulare*.
(6) In Latin, *Trilobatum*.
(7) In Latin, *Quadrangulare*.
(8) In Latin, *Panduræforme*.
(9) In Latin, *Deltoideum*.
(10) In Latin, *Rhomboideum*.

pair at the base are long, the plate of the leaf is often more or less regularly formed to correspond with this, and becomes five-lobed[1], as in the hop and sycamore; hand-shaped[2], as in the blue passion-flower; slashed[3], as long-stalked geranium; five-cleft[4], as in spotted geranium; many-cleft[5], as in monk's hood; cleft-cut[6], as in dandelion; wing-cleft[7], as in star-thistle; or comb-cleft[8], as in water violet.

Simple Leaves.—The reference figures correspond with those in the text of the preceding paragraph.

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(1) In Latin, *Quinquelobatum*.
(2) In Latin, *Palmatum*.
(3) In Latin, *Laciniatum*.
(4) In Latin, *Quinquefidium*.
(5) In Latin, *Multifidum*.
(6) In Latin, *Runcinatum*.
(7) In Latin, *Pinnatifidum*.
(8) In Latin, *Pectinatum*.

Compound Leaves.

The branches of the mid-rib, instead of forming with the connecting textures of the leaf a single plate, divide it in many species into several smaller plates, so that the main leaf-stalk supports a number of small leaves or leafits *, not merely deeply cut divisions, as in the wing-cleft and other simple leaves. The leafits are accordingly denominated in a similar manner to the simple leaves. It will therefore be altogether unnecessary for me to repeat in this place the terms enumerated in the preceding paragraphs, with which I presume the beginner has already become quite tired, though they are in some degree indispensable in order to understand botanical descriptions.

When there is a common leaf-stalk supporting two or more leafits, the compound leaf may be three-fold [1], as in clover; four-fold [2], as in four-leaved marsilea; five-fold [3], as in red horse-chestnut; fingered [4], as in cinque-foil; many-fold [5], when the leafits are more than seven; umbelled [6], when the leafits are disposed like an umbrella, as in several lupins; and yoked [7], when the leafits are attached to the sides and not to the top of the leaf-stalk.

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* In Latin, *Foliola.*

(1) In Latin, *Ternatum* or *Trifoliatum.*

(2) In Latin, *Quaternum.*

(3) In Latin, *Quinatum.*

(4) In Latin, *Digitatum.*

(5) In Latin, *Multipartitum.*

(6) In Latin, *Umbellatum.*

(7) In Latin, *Jugatum.*

Compound Leaves.—The reference figures correspond with those in the text of the preceding paragraph.

When a number of distinct leafits[1] are placed along the sides of the common leaf-stalk, the compound leaf is said to be winged[2], and may be abruptly winged[3], as in mimosa; unequally winged[4], as in roses; tendril-winged[5], as in the pea; lyre-winged[6], as in winter green; oppositely winged[7], as in saint-foin; alternately

(1) In Latin, *Pinnæ.* (2) In Latin, *Pinnatum.*
(3) In Latin, *Abruptè pinnatum.* (4) In Latin, *Imparè pinnatum.*
(5) In Latin, *Cirroso pinnatum.*
(6) In Latin, *Lyrato pinnatum.*
(7) In Latin, *Oppositè pinnatum.*

winged[8], as in the wood vetch; interruptedly winged[9], as in meadow sweet; jointedly winged[10], as in winged weimannia; whirl-winged[11]; or vertebrated[12].

Compound Leaves.—The reference figures correspond with those in the text of the preceding paragraph.

When the small leafits of a winged leaf are again divided into leafits, the whole leaf is said to be doubly

(8) In Latin, *Alternè pinnatum.*
(9) In Latin, *Interruptè pinnatum.*
(10) In Latin, *Articulato pinnatum.*
(11) In Latin, *Verticillato pinnatum.*
(12) In Latin, *Vertebratum.*

compound[1]; and the divisions may be in twos[2] threes[3], or more[4], as in columbine, fumitory, carrot, or fennel.

Compound Leaves.—The reference figures correspond with those in the text.

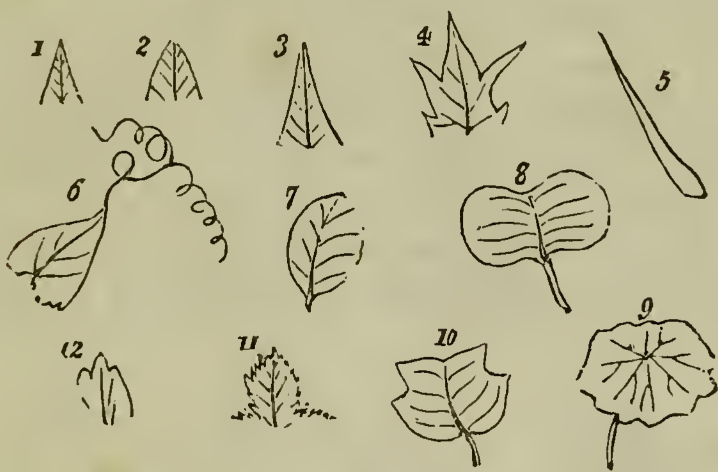
Circumference of Leaves.

The terms applied to the various characteristics of the circumference of leaves, which may be conveniently divided into the tips and the margins, are rather numerous and puzzling to beginners.

A leaf, as to the tip*, may be sharp[1]; sharpish[2];

(1) In Latin, *Decompositum*. (2) In Latin, *Bigeminatum*.
(3) In Latin, *Trigeminatum*. (4) In Latin, *Multipinnatum*.
(*) In Latin, *Apex*. (1) In Latin, *Acutum*.
(2) In Latin, *Subacutum*.

tapering[3], as in the lilac; spine-pointed[4], as in thistles; awned[5]; tendrilled[6]; blunt[7]; as in Saint Peter's wort; bluntly notched[8], as in mountain sorrel; sharply notched[9], as in navel wort; abrupt[10], as in the tulip tree; jagged[11], as in the jagged hibiscus; three-toothed[12]; or unpointed[13].



Tips of Leaves.—The reference figures correspond with those in the text of the preceding paragraph.

As to the margin[14], the leaf, taking the whole round, with the exception of the tip and the insertion of the leaf-stalk, may be entire[15], as in goat's beard; or indented[1], in various manners, being waved[2], as in the

(3) In Latin, *Acuminatum*.
(4) In Latin, *Cuspidatum*. (5) In Latin, *Aristatum*.
(6) In Latin, *Cirrosum* or *Circinatum*.
(7) In Latin, *Obtusum*. (8) In Latin, *Retusum*.
(9) In Latin, *Emarginatum*. (10) In Latin, *Abruptum*.
(11) In Latin, *Præmorsum*. (12) In Latin, *Tridentatum*.
(13) In Latin, *Muticum*. (14) In Latin, *Margo*.
(15) In Latin, *Integrum*.
(1) In Latin, *Indentatum*. (2) In Latin, *Sinuatum*.

oak; gnawed[3], as it were irregularly; toothed[4], as in the throat wort; and this may be equally, unequally, slightly, deeply, singly, or doubly toothed; sawed[5], as in the orpine, and this may be varied as in the toothed margin; scalloped[6], as in betony, and this may be tooth-scalloped, doubly-scalloped, slightly or deeply-scalloped; thorny[7], as in common holly; or prickly[8], as in the spear thistle. The margin may be bordered[9], when the substance is of different texture, and this may be gristly[10], as in Adam's needle; horny[11]; fringed[12]; or glandular[13]. The margin may also be rolled[14]; and this may be rolled backwards[15]; rolled forwards[16]; wavy[17], as in base rocket; or curled[18], as in double parsley.

The figures correspond with those in the following paragraph.

(3) In Latin, *Erosum.*
(4) In Latin, *Dentatum.*
(5) In Latin, *Serratum.*
(6) In Latin, *Crenatum.*
(7) In Latin, *Spinosum.*
(8) In Latin, *Aculeosum.*
(9) In Latin, *Marginatum.*
(10) In Latin, *Cartilaginosum.*
(11) In Latin, *Corneum.*
(12) In Latin, *Ciliatum.*
(13) In Latin, *Glandulosum.*
(14) In Latin, *Volutum.*
(15) In Latin, *Revolutum.*
(16) In Latin, *Involutum.*
(17) In Latin, *Undulatum.*
(18) In Latin, *Crispum.*

Insertion and Direction of Leaves.

In relation to the stem or branch on which it grows, a leaf may be embracing[1], as in the white poppy; sheathing[2], as in grasses; clasping or riding[3], as in iris; connate[4], as in teasel; decurrent[5], or running down on each side from the base, as in comfrey; or perfoliate[6], as if pierced by the stem.

With respect to their distribution, leaves may be opposite[7], as in the nettle; crossing in pairs[8], as in caper spurge; in threes[9], as in three-leafed vervain; in fours[10], as in some heaths; cross-formed[11], as in cross wort; whorled[12], as in woodroof; alternate[13], as in vervain mallow; spiral[14], as in spruce fir; scattered irregularly[15]; in two ranks[16], as in the yew tree; tufted[17], as in the larch; crowded[18], as in chick-weed and winter-green; or rose-like[19], as in rose bryum.

With respect to direction, leaves may be erect, appressed[20], spreading, horizontal, nodding[21], curved backwards[22], curved upwards[23], drooping[24], twisted,

(1) In Latin, *Amplexicaulium.*
(2) In Latin, *Vaginans.*
(3) In Latin, *Equitans.*
(4) In Latin, *Connatum.*
(5) In Latin, *Decurrens.*
(6) In Latin, *Perfoliatum.*
(7) In Latin, *Opposita.*
(8) In Latin, *Decussata.*
(9) In Latin, *Ternata.*
(10) In Latin, *Quaternata.*
(11) In Latin, *Cruciata.*
(12) In Latin, *Verticillata.*
(13) In Latin, *Alternata.*
(14) In Latin, *Spiralia.*
(15) In Latin, *Sparsa.*
(16) In Latin, *Bifaria.*
(17) In Latin, *Fasciculata.*
(18) In Latin, *Conferta.*
(19) In Latin, *Rosea.*
(20) In Latin, *Appressa.*
(21) In Latin, *Nutantia.*
(22) In Latin, *Reflexa.*
(23) In Latin, *Inflexa.*
(24) In Latin, *Pendula.*

reversed [1], on one side [2], procumbent, submersed, floating [3], or emerging out of water.

With respect to duration, leaves either fall off in summer, at the approach of winter, or are evergreen. When they wither and remain without falling, they are said to be persistent [4], as in oak and beech.

Leaf, Flower, and Fruit Scales.

At the bases of leaves, there is in most species a member similar to a leaf, most commonly small, as in the hedge vetch, but larger than the leaf itself in the pea; this I term the leaf-scale [5], which is always double, or in pairs. The leaf-scale in heart's-ease is lyre-winged; in the rose it is on the leaf-stalk, and in grasses it is a white gouge-formed membrane at the inner base of the leaf. This, however, is not considered by some to be a leaf-scale, but a crown like that in the flowers of catch-fly; yet both this, and also the sheathing-scale [6] of rhubarb, bistort, and buckwheat, are certainly leaf-scales.

There are somewhat similar leaf-like members, often coloured otherwise than green, in many species on the flower-stalk, which may be called the floral leaf, or flower-scale [7], as in the lime tree and the purple clary.

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(1) In Latin, *Resupinata.*

(2) In Latin, *Unilateralia* or *Secunda*

(3) In Latin, *Fluitantia.*

(4) In Latin, *Persistentia.*

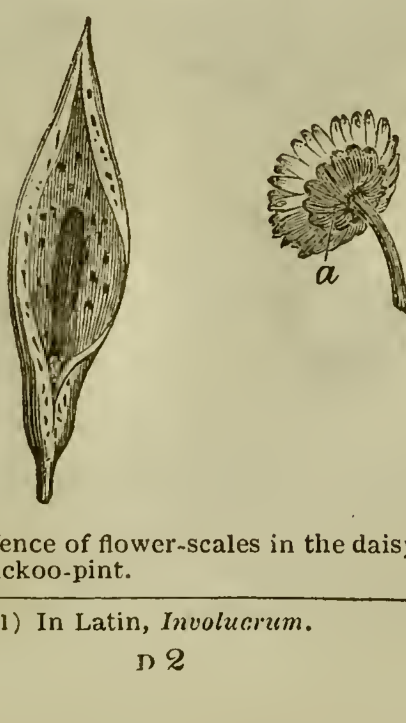
(5) In Latin, *Stipula.*

(6) In Latin, *Ochrea.*

(7) In Latin, *Bractea.*

Leaf-scales and flower-scales.—*a*, *a*, leaf-scales of the heart's ease: *b*, the leaf; *c*, flower-scale of the lime tree; *d*, the leaf.

In the carrot and hemlock there are flower-scales both at the base of the large umbels and the small umbels, sometimes termed the fence[1]. The fences of flower-scales in the daisy and dandelion are placed circularly in a single or double row, imme-

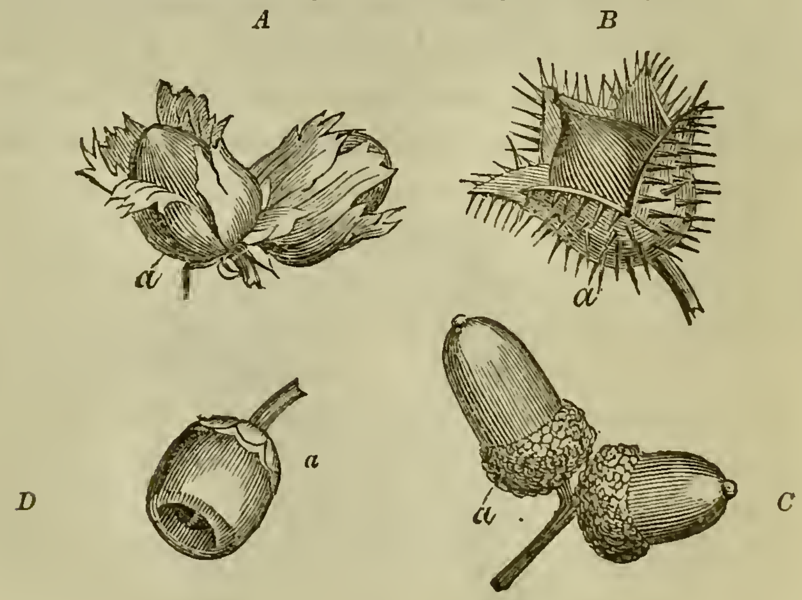


Flower-scales.—*a*, fence of flower-scales in the daisy; *b*, sheathing flower-scale in cuckoo-pint.

(1) In Latin, *Involucrum*.

diately below the flower-cup. In corn and grasses, the flower-scale consists of the two outer envelopes, usually termed husk [1], which sometimes are tipped with what is called an awn [2]. In lilies, cuckoo-pint, and the palms, the flower-scale is in form of a sheath [3], which had previously enwrapt the flower-bud.

In some cases, scales similar to the preceding do not expand till the fruit advances in growth, and hence they may be termed fruit-scales [4], which are leafy and nearly surrounding the nut in the filbert; leathery and rough, quite surrounding the nut, in beech and chestnut; woody and hard, and forming a cup for the acorn, in the oak; and fleshy like a berry, in the yew.



Fruit-scales, *a*, *a*, *a*, *a*. *A*, in the filbert; *B*, in the beech; *C*, in the oak; *D*, in the yew.

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(1) In Latin, *Gluma*. (2) In Latin, *Arista*.
(3) In Latin, *Spatha*. (4) In Latin, *Cupula*.

BRANCHES.

Buds give origin, as we have seen, to branches, as well as to leaves and flowers; but the branch [1], being a portion of the body or stem of the plant, exactly resembles it in structure, and is always of course younger by at least one season in trees. It might be supposed that the stem of a plant would measure as much, or perhaps more, than the head of branches [2] which spring from it, and which it has to support and nourish. So far, however, from this being the case, Du Hamel found by actual measurement, that the solid contents of the whole branches may often be at least a fourth or a fifth more, the trunk usually increasing more slowly than the branches, though it grows gradually more compact, and therefore furnishes the best timber.

From this circumstance, trees with crowded branches are apt to be weakened and exhausted, and hence the operation of pruning is resorted to for the purpose of repressing luxuriance. As trees, however, do not thrive well without a due supply of leaves, which usually grow on the branches and seldom on the stem, when all the branches are cut off, the tree often dies before it can push out a sufficient number of branches, as I have seen happen with the cherry and the poplar. When the tree is vigorous, it survives the loss of its branches, and pushes out fresh ones in a crowded form, as may be seen in the acacias in Belgium, which look more like mops than trees: the pollard willows and the mutilated elms near London are produced by a similar

(1) In Latin, *Ramus*. (2) In Latin, *Coma*, improperly *Cyma*.

practice. In closely crowded woods, and particularly in pine forests, the want of free air suffocates many of the lower branches, which die, and are thus in a manner pruned by nature.

The branches, like leaves, may be opposite, alternate, whorled, irregularly dispersed, descending, drooping, as in the weeping willow, or possess various modes of bending. It is worthy of remark, that the sprays or branchlets of trees are much the same in the same species, a circumstance well described by Gilpin, and of considerable interest to landscape painters.

SCALES, HAIRS, PRICKLES, AND THORNS.

The rind of many plants, instead of a smooth bald surface, is clothed with various species of scales, down, wool, cotton, silk, hair, bristles, prickles, and thorns, about whose use various opinions have been held.

The scales [1] here meant are entirely different in structure from the leaf-scales and flower-scales formerly described, not having, like these, the character of leaves, and hence the scale-like appearance in pine shoots are not scales but young leaves. Scales are found abundantly on the leaf-stalks of ferns. The beginner must not confound with these scales the bark scales thrown off by some trees, nor the lichens which often encrust bark.

Hairs [2] on plants, somewhat similar to those on animals, arise, according to Du Hamel, from small bulbs, either within the rind or the first layer of the inner

(1) In Latin, *Ramentæ*. (2) In Latin, *Pili*.

bark. They are not found on roots, or on parts that grow under water. They are often like simple threads, but frequently also like cells, stretched out lengthwise, and threaded on each other; having often, instead of a sharp point at the tip, a minute nipple or vesicle, which gives out an oily or sticky fluid, sometimes coloured. Examples may be found in the clammy groundsel, the moss-rose, the sun-dew, and the fly-bush of the Cape of Good Hope. In the chick pea, the hairs on the leaves are tipped, as Deyeux has described, with little transparent globules, if the plant be in the sunshine; which, when wiped away, are speedily renewed; but at night, and in dull damp weather, they disappear till the sunshine returns.

According to the aspect of what has here been called by the general name of hair, plants are said to be downy [1], cottony [2], silky [3], woolly [4] or bristly [5], and a number of distinctions, even still more minute, have been made; when the hairs are in rows, they are termed fringes [6].

The hairs of some plants, such as mullein or shepherd's club, make the leaves look like thick flannel, or the felt of a hat, intended, it should seem, to prevent too rapid evaporation, and in Alpine plants to protect them from cold. At the Cape of Good Hope, advantage is taken of this to form wearing apparel.

Hairs and bristles on plants are sometimes simple

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(1) In Latin, *Pubens*.
(2) In Latin, *Tomentosus*. (3) In Latin, *Sericeus*.
(4) In Latin, *Lanatus*. (5) In Latin, *Hispidus*.
(6) In Latin, *Ciliæ*, whence *Ciliatus*.

and sometimes jointed[1], forked[2], branched[3], tufted[4], starred[5], hooked[6], or feathered[7]. When very long and stiff, as in the bearded wheat, and the Russian oat, the bristle is termed an awn[8].

Prickles[9] have much the same characteristics as hairs, but are thicker and stronger, and always tipped with a sharp point. They arise wholly from the bark, and never from the woody part of a plant, as thorns always do. According to Grew, prickles, as in the thistle and the acacia, always point downward, while all thorns point upwards.

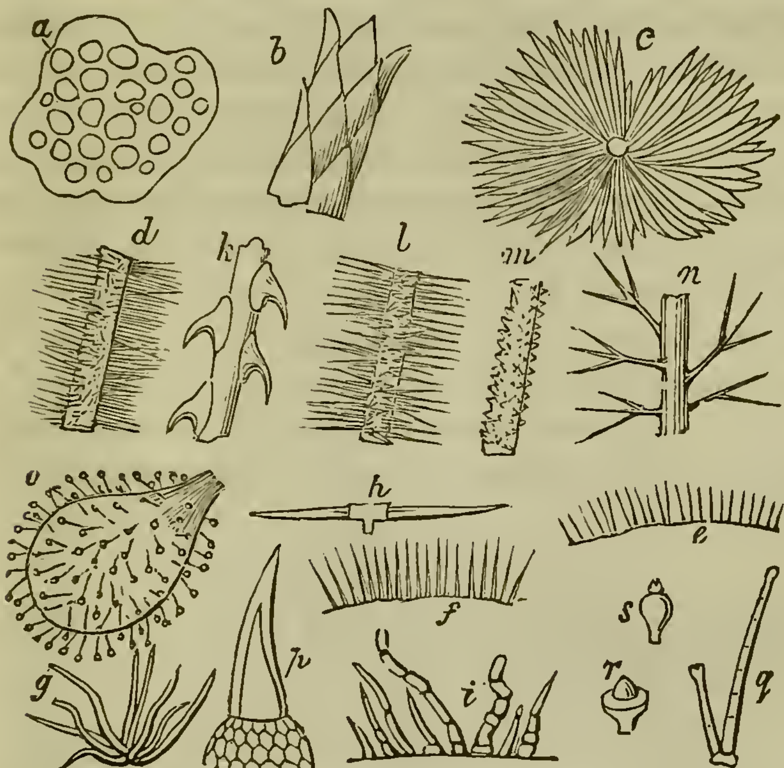
In the stinging nettle, the prickles[10], as described by Hook, arise from bulbs, containing an acrid fluid, which, upon their being pressed down, is forced up into their hollow tubes, and discharged through minute pores in the tips, in a similar way to the poison discharged through the fang of a viper, or the sting of a wasp.

Thorns[11] differ from hairs or prickles in being woody, and not superficially inserted in the bark.

It has been most absurdly fancied that thorns are abortive or degenerated buds, branches, leaf-scales, and leaf-lobes, for want of sufficient nourishment, because, when highly cultivated, the thorns disappear. On the same untenable principle it might be maintained that the hairs on the wild carrots are abortions which disappear in the garden; or that the stamens and pistils

(1) In Latin, *Articulatus*.
(2) In Latin, *Furcatus*.
(3) In Latin, *Ramosus*.
(4) In Latin, *Fasciculatus*.
(5) In Latin, *Stellatus*.
(6) In Latin, *Uncinatus*.
(7) In Latin, *Plumosus*.
(8) In Latin, *Aristæ*, or *Barbæ*.
(9) In Latin, *Aculei*.
(10) In Latin, *Setæ urentes*.
(11) In Latin, *Spinæ*.

of the wild rose are abortive petals, as they do become petals in the double cultivated roses. It is surely as natural for the sloe or the holly to bear thorns, as for any tree to bear leaves.



Scales, Hairs, Prickles, and Thorns.—*a*, leprous scales; *b*, triangular scales; *c*, star-formed scale; *d*, shaggy hairs; *e*, *f*, fringe of hairs; *g*, star-like hairs; *h*, hair fixed by its middle; *i*, jointed and simple hair; *k*, simple prickles; *l*, bristles; *m*, warty; *n*, three-pronged thorns; *o*, glandular hairs; *p*, cellular hair magnified; *q*, glandular hair magnified; *r*, *s*, the glandular tips magnified.

GLANDS.

What are termed glands [1] in plants seem to have little analogy with animal glands, consisting usually of

(1) In Latin, *Glandulæ*.

small globular bodies placed on the tips of hairs, as in the sun dew and moss-rose, or elsewhere on the surface; whereas animal glands are always internal. Some botanists, indeed, describe internal glands, but nothing precise has been ascertained respecting these, except in the transparent points supposed to be glandular, in the leaves of myrtle, orange, and St. John's wort. Guettard and De Candolle describe, besides, root-buds or uticular glands [1], as on the willow and others, filled with a colourless fluid, as in the ice plant; globular, such as those on the leaves of sage; and papillary, like the tasters on the human tongue, as in savory; and cup-like, as in the passion-flower.

The singular vessel which holds water in the pitcher-plant, may be considered perhaps as a sort of gland.

CLASPERS AND TENDRILS.

SEVERAL climbing plants, such as the hop, kidney bean, and honeysuckle, have no peculiar instruments to aid them in climbing, unless we consider as such the rough reversed prickles of the hop; but many plants have members admirably contrived for this purpose. The ivy, for example, is furnished with a close set row of claspers [2] (erroneously taken for roots) on each side of the stem, which enables it to climb up any surface tolerably rough, such as a wall or an old tree; and because it is rarely seen on a young tree, on whose smooth bark it finds it difficult to climb, it has been inferred that it only attacks and injures sickly trees, though the fact is, that it derives all its nourishment

(1) In Latin, *Lenticellæ*. (2) In Latin, *Tentacula*.

from its roots in the earth, and cannot injure any tree.

The form of tendrils [1], another sort of claspers, is very various, being simple in the passion-flower [2], and branched in the pea [3]. The tendril sometimes rises from the inner base of a leaf, and sometimes from its tip [4], as may be seen in the vine, traveller's joy, vetches, and numerous other climbing plants. These are evidently produced by the lengthening of the midrib of the leaf.

FLOWERS.

As it will be necessary to consider flowers afterwards under the head of "Reproductive Organs," I shall, in noticing them here as members, attend only to their outward form, beginning at their origin from a stem or branch, and proceeding upwards.

According to the partially fashionable, but wildly absurd theory lately introduced,—first, if I mistake not, by the German poet, Goethe,—a complete flower is represented to be the union of four whorls of leaves variously modified. In the same vein, Von Martius, of Munich, announces as a profound discovery that a plant is nothing but a leaf which has made a determinate number of revolutions, and hence all leaves ought by theory to grow alternately; but it being found that many leaves do not grow alternately, but one opposite

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(1) In Latin, *Cirri*.

(2) See the figure, page 55.

(3) See the figure, page 29, Nos. 5 and 8.

(4) See the figure, page 31, No. 6.

to another, it is said this arises from the regular theoretical lengthening of the stem upwards being checked till the opposite leaf expands, a check that is uniform in the seed-leaves of those plants which have two seed-lobes. I submit to any reader endowed with common sense, that this is not science, but fanciful romance, of similar character to Van Helmont's Archæus, and Darwin's gnomes and sylphs, though it is loudly trumpeted forth as being founded on rigid and accurate observation.

THE FLOWER-STALKS AND INFLORESCENCE.

UNNECESSARY intricacy, if not baneful confusion, as it appears to me, has been introduced into Botany, by giving a variety of names to the flower-stalk [1] in various species. Some flowers have no flower-stalk, and are termed sitting.

Flower-stalks are either simple, supporting only one flower, as in wood anemone; or supporting more flowers than one upon stalklets [2], as in the cowslip and lilac.

Simple flower-stalks may either spring from the root, from the stem, or from a branch, and be either solitary, or more than one together, as in the black mullein.

Compound flower-stalks may be variously arranged and named, but I shall follow Professor Röper of Bâle, as the most modern, if not the best, in the midst of much confusion. Röper considers the modes of flowering [3] as consisting of an evolution, which may be

(1) In Latin, *Pedunculus*, and unnecessarily *Scapus, Rachis*, &c.
(2) In Latin, *Pedicelli.* (3) In Latin, *Inflorescentia.*

centripetal, centrifugal, or mixed. This arrangement, however, I ought to mention, evidently originated from the wild theory of Goethe and Von Martius, to which I have just objected; but as it is here introduced, I have completely stript it of all theory and only given what is based on facts; for there is a wide difference between the representation of flowers being actually leaves transformed into flowers by rotatory evolution, and the simple fact that the flowers of certain plants are evolved in a certain order and direction.

Centripetal Evolution.

In the centripetal evolution, the flowers always first blow in the circumference and last in the centre, the flower-stalk always growing from the inner base [1] of a leaf, and the stem having always a leaf-bud at the summit. The flowering may therefore be prolonged indefinitely, or as long as nourishment is afforded. We may also consider the various forms arising from the varied growth of the branches of the flower-stalk, as we have seen occurring in the leaf-stalks, with regard to their distribution through leaves.

The form under this division may be that of a tuft [2], as in clover, scabious, and thrift, which rank as aggregate [3] flowers; or as in dandelion, thistle, and daisy, which rank as composite [4] flowers, the first being usually more or less globular, the second more or less

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(1) In Latin, *Axilla*.
(2) In Latin, *Capitulum*.
(3) In Latin, *Aggregati*.
(4) In Latin, *Compositi*.

flat[1]. Linnæus termed these compound flowers, and Link defends him: Professor Lindley says it would be equally accurate to call "a flock of sheep a compound sheep." It may be a catkin[2], as in the hazel, the willow, the beet, the birch, the fir, the walnut, and the poplar, which Linnæus confounded with the flower-cup. It may be a spike[3], as in lavender, agrimony, foxglove, wheat, barley, and many grasses, consisting of a common stalk supporting numerous flowers; cylindrical, as in plantain; jointed, as in glasswort; forked, as in heliotrope; or branched, as in mercury. In many grasses and other plants the flower-stalk[4] has a number of spikelets[5], which with their parts have received several unnecessary names. It may be a panicle[6], as in horse-chestnut, London-pride, oats, and many grasses, consisting of a diffused branching spike, of which the spikelets arise from a common stalk. It may be a cluster[7], which is either simple without branches, as in the red currant; compound with branches, as in the vine; or in form of a bundle, whose lower branches raise their flowers nearly to the same level. Or it may be an umbel[8], as in parsley, carrot, and hemlock, consisting of small stalks branching from the same point, and rising nearly to the same level, termed sitting, when the rays go from a stem or branch,

(1) A flat tuft is termed in Latin, *Anthodium*.

(2) In Latin, *Amentum*. (3) In Latin, *Spica*.

(4) In Latin, *Rachis* or *Scobina*.

(5) In Latin, *Locustæ* or *Spicula*.

(6) In Latin, *Panicla*. (7) In Latin, *Racemus*.

(8) In Latin, *Umbella*.

as knotted water parsnep; simple, when single flowered, as in stone parsley; and compounded, when each main ray, as in fennel, branches at the summit into a second and smaller umbel [1]. The focus of the main rays has often below it one or more small flower-scales, sometimes termed a fence [2], and a similar smaller flower-scale [3] often occurs at the junction of the smaller umbels.

Flowers.—Centripetal evolution. *a*, tuft (clover); *b*, catkin (poplar); *d*, spike (foxglove); *e*, cylindrical spike (plantain); *f*, forked spike (heliotrope); *g*, panicle (oats); *h*, umbel with its fence (carrot).

In Latin, *Umbellula*.

(2) In Latin, *Involucrum*. (3) In Latin, *Involucellum*.

Centrifugal Evolution.

In the centrifugal evolution, each branch or flower-stalk terminates in a flower-bud, never in a leaf-bud, and consequently it cannot be prolonged farther, as in the centripetal, though it may shoot out fresh flower buds from the sides, when nourishment is afforded. Instead of a single floral leaf, each top flower has two or more, and from the inner base of these two or more new branches spring, each again ending in a central flower, and two or more side branches. They proceed forking off in this manner, till the supply of nourishment is exhausted. All the flowers in the centre open first.

The form under this division may not inappropriately be termed in general a bouquet[1]; but when the branches from the flower-stalk are wanting or very short, it is termed a ball[2], though differing only from the tuft in its evolution. The bouquet, when the side branches are very short, and the flowers crowded together, is termed a fascicle[3], as in sweet-william. The bouquet is in some instances only simply forked, as in silene and some of the pinks; triply, or oftener forked, as in spurge; or not forked at all, no flowers being evolved on one side, as in bugloss and scorpion-flower. Sometimes the bouquet resembles an umbel, and sometimes a bundle, but is always distinguished by its peculiar evolution.

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(1) In Latin, *Cyma*. (2) In Latin, *Glomus* or *Glomerulus*.
(3) In Latin, *Fasciculus*.

Flowers.—Centrifugal evolution. *a*, fascicle (sweet-william); *b*, simply forked bouquet (silene); *c*, triply forked bouquet (spurge); *d*, irregular bouquet (bugloss).

Mixed Evolution.

In the mixed evolution there are two leading forms,—one where the central axis of the plant flowers according to the centripetal evolution, and the side branches to the centrifugal, which is termed a bunch [1], as in the lilac and the butter burr; and also in the plants whose flowering was formerly termed the whorl [2], as in mint, balm, thyme, and sage: and of this there are many

(1) In Latin, *Thyrsus*. (2) In Latin, *Verticillus*.

varieties, according as it resembles a panicle, a cluster, or a spike: another, when the central axis follows the centrifugal evolution, and the side branches the centripetal, which is termed a bundle[1], as in yarrow.

Flowers.—Mixed evolution. *a*, bunch (lilac); *b*, bundle (sneeze wort yarrow).

The Flower-cup.

Great attention has been paid to the different forms observable in the outer envelope[2] of flowers, and several terms are used for these among botanists for the sake of distinctness, but to beginners they are often very puzzling, particularly as different authors give different meanings to the same term. What is more objectionable, Jussieu, Lamouroux, and others, term a flower perfect or complete when it has a certain

(1) In Latin, *Corymbus*.
(2) In Latin, *Perigonium* (De Candolle).

number of parts, and *imperfect* or incomplete when one or more of these is wanting.

It will simplify this, as I conceive, to consider the floral envelope as in all cases the expanded bud-scales of the flower, which enwrapped and protected it while in embryo, and which afterwards fall off, as in the poppy, or remain, as in the rose, after flowering.

In mushrooms and other funguses, the part analogous to the scales of the expanded flower-bud is termed the curtain [1], which varies in being near or distant from the cup.

In mosses, the analogous part is termed a veil [2], which is very distinctly seen in the hair moss and the hygrometric moss.

In grasses and corn the scales of the expanded flower-bud are termed a husk [3], which may consist of only one piece, as in rye-grass; two pieces, as in hair-grass; or many pieces, as in panic grass. All the husks are called chaff [4].

In many bulbous and other plants the expanded scales of the flower-bud form a sheath [5] of one piece, as in the snowdrop and daffodil; of two pieces, as in water soldier; tiled, as in the plantain tree; or partial, as in African ixia.

In all the preceding varieties, the part in question is rarely green, and most commonly some shade of yellow or white; but in the greater number of flowers it is green, very similar in appearance and structure to

(1) In Latin, *Volva*. (2) In Latin, *Calyptra*.
(3) In Latin, *Gluma*. (4) In Latin, *Palea*.
(5) In Latin, *Spatha*.

leaves, either united or separate in form of a whorl, and is termed simply the flower-cup[1], or, along with the blossom, the flower-envelope[2]. By some hallucination not unusual in science, the latter term is applied to the fruit[3], as in mercury, and to the fructification[4], as in the bramble. I think it would be well to banish a term so involved in confusion. This species of flower-cup may be composed of several leaves united into one leaf[5], as in the primrose, which may again be partially cut or divided; or of two leaves, as in the poppy; of three leaves, as in the dock; or of many leaves, as in butter-cup, wall-flower, and water-cress.

It may be necessary to remark, that the one-leafed flower-cup usually remains, and sometimes grows, after the formation of the seed, as in winter cherry. It is said to possess a tube at the base, a throat in the middle, and a border at the summit, the latter of which is often toothed, cleft, or divided, more or less deeply or regularly, and may be seen in various forms,—bulged, bell-shaped, pear-shaped, prismatic, spurred, lipped, or winged. The many-leafed flower-cup may have two leaves, termed by some sepals, as in fumitory; three leaves, as in pilewort; four leaves, as in cabbage; or five leaves, as in flax. It rarely remains after the seed is formed.

(1) In Latin, *Calyx*.
(2) In Latin, *Perianthium* or *Perigonium*.
(3) In Latin, *Perianthium fructus*.
(4) In Latin, *Perianthium fructificationis*.
(5) In Latin, *Sepalum*, an unnecessary barbarous term.
(6) In Latin, *Monophyllus* or *Calyx Gamosepalus*.

In composite flowers, such as the thistle and the dandelion, each floret[1] arises from a peculiar sort of envelope termed the down-cup[2], which may be hairy, feathered, bristly, chaffy, or rimmed. It is in some cases indistinct or wanting, and in others it is double, when the outer leaves may be considered flower-scales or husks. The envelope of the seeds in cotton is not a down-cup.

The flower-cup may be placed so as to crown the fruit, when it is termed superior, as in the rose and apple; or so as to surround the base of the fruit, when it is termed inferior, as in the poppy and the water lily. By the. theory, however, or rather the fancy of Goethe and De Candolle, the flower-cup ought never to be superior.

The Receptacle.

When the summit of the stem on which the flower rests is flattened instead of being lengthened out into a stalk, it is termed the receptacle[3] or bed, and is either proper or common. It is proper when one receptacle corresponds with a single flower, as in the white lily and the tulip. This receptacle is usually fleshy, as in the fig. It would appear that what we called the berry of the strawberry, is nothing more than the receptacle bearing the naked seeds on its surface, and the pear-

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(1) In Latin, *Corollula*. (2) In Latin, *Pappus*.
(3) In Latin, *Receptaculum* or *Torus*.

like substance on which the cashew nut grows is also only a receptacle. It is common in the instance of composite flowers, such as the daisy and thistle, when a number of florets rest on one receptacle. A good notion may be formed of this receptacle by blowing the downy seeds from the head of a dandelion,—the round bottom which is thus exposed being the common receptacle.

There is often a peculiar prolongation of the receptacle[1], which remains when the pistil is detached, as in the raspberry; but this must not be confounded with a contraction of the base of the seed organ[2], as in the poppy.

The Blossom.

I shall term that part of the flower contained immediately within the flower-cup the blossom[3], though it is not in all cases agreed what part is to be called the cup, and what the blossom; for instance, in the orchis, the narcissus, and mezereon, though popularly supposed to have finely-coloured blossoms, M. A. Richard, and other eminent botanists, deny that they have any blossom at all, the coloured flowers consisting only of the cup. In the Virginian spider wort, water plantain, and arrow head, there are six divisions in the flower; three outer, which are green, and which most people would be disposed to consider the flower-cup, and three inner, variously coloured, which to a simple

(1) In Latin, *Gynophorum*. (2) In Latin, *Podogynum*.
(3) In Latin, *Corolla*.

person would appear to be the blossom. Yet M. A. Richard maintains that all the six form nothing but a flower-cup, and that the blossom is wanting. In a similar manner he explains the structure of the flower of the orchis. What again is popularly supposed to be the lilac or blue blossoms of the hydrangea, are shown by De Candolle not to be even the flower-cup, but merely floral leaves or flower-scales.

It has been proposed, when there is only one envelope in a flower, to call that the cup, whether it be coloured or not; and when two, to call the outer the flower-cup and the inner the blossom. When the flower-cup and blossom have several divisions or leaves, these always alternate, and consequently correspond in number. In water lilies there are more than two whorls, and in the passion flower the numerous thread-like petals within the outer whorl are of this kind.

Blue Passion Flower.

In most flowers, however, the blossom is the part which is commonly some other colour than green, and in different species is exceedingly varied in form ; but it will be less necessary to describe these minutely, as the same terms, in most instances, apply to them as those already mentioned which apply to the flower-cup. The leaves into which the blossom may be divided, are termed petals [1], the base being termed the claw [2], and the rest the limb [3]. With respect to indentations and divisions, the same terms are applicable as to the leaves.

When the blossom consists of only one petal [4], falling off, when about to wither, in a single piece, it may be, as to form, either regular or irregular.

The regular one-petaled blossom may be tubular [5]. when the opening is called the throat [6], as in the lilac and primrose; bell-shaped [7], as in Canterbury bells and rampion; funnel-shaped [8], as in tobacco; salver-shaped [9], as in jasmine; wheel-shaped [10], as in borage and potato; star-shaped [11], as in ladies' bed straw; pitcher-shaped [12], as in many heaths; egg oblong, as in the strawberry tree, and some heaths; globular, as in some Andromedas ; goblet-shaped, as in comfrey ; and club-shaped, as in pine heath, and some other species.

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(1) In Latin, *Petala.*
(2) In Latin, *Unguis.* (3) In Latin, *Lamina* or *Limbus.*
(4) In Latin, *Corolla monopetala* or *gamopetala.*
(5) In Latin, *Tubularis.* (6) In Latin, *Faux.*
(7) In Latin, *Campanulata.* (8) In Latin, *Infundibiliformis.*
(9) In Latin, *Hypocrateriformis.*
(10) In Latin, *Rotata.* (11) In Latin, *Stellata.*
(12) In Latin, *Urceolata.*

Regular Blossoms :—1, tubular (primrose) ; 2, bell-shaped (Canterbury-bell) ; 3, funnel-shaped (tobacco) ; 4, salver-shaped (forget me-not) ; 5, wheel-shaped (borage) ; 6, star-shaped (ladies' bed straw) ; 7, pitcher-shaped (heath).

The irregular one-petaled blossom may be ringent[1], as in archangel, the two divisions being termed the upper and lower lip[2], or the helmet[3] and beard, with the gape[4], between these leading back to the palate and throat ; or masked[5], as in snap-dragon and toad-flax ; ligulated[6], as in dandelion and daisy ; or anomalous, as in fox-glove, butter-wort, and hooded milfoil.

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(1) In Latin, *Ringens* or *Labiata*.
(2) In Latin, *Labium*. (3) In Latin, *Galea*.
(4) In Latin, *Rictus*. (5) In Latin, *Personata*.
(6) In Latin, *Ligulata*.

Irregular Blossoms,—*a*, ringent (archangel); 9, 9, the lips; 10, helmet; 11, gape; *b*, masked (snap-dragon); *c*, anomalous (butterwort).

When the blossom has more petals than one [1], it may in the same manner, as to form, be regular, as in wall-flower and bramble; or irregular, as in the bean.

The regular blossom of more petals than one may be cross-formed [2], as in cabbage and water-cress; rose-formed [3], as in the rose and cherry; or pink-formed [4], as in carnation and soapwort.

The irregular blossom of more than one petal may be butterfly-formed [5], as in the pea and broom, the upper part being termed the standard [6], the two sides termed the wings [7], and two under pieces termed the keel [8]: or it may be anomalous, as in violet, larkspur, monkshood, balsam, and nasturtium.

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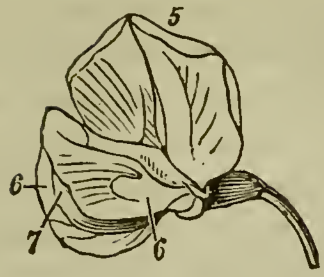
(1) In Latin, *Corolla polypetala.*

(2) In Latin, *Cruciata.* (3) In Latin, *Rosacea.*

(4) In Latin, *Caryophyllata.* (5) In Latin, *Papilionacea.*

(6) In Latin, *Vexillum.* (7) In Latin, *Alæ.*

(8) In Latin, *Carina.*



Butterfly-formed Blossom.—Sweet Pea. 5, the standard; 6, 6, wings; 7, keel.

In some plants there is at the inner base of the petals an expansion which forms in the daffodil a cup-like crown [1], and in stapelia forms a thick covering [2] to the seed organ.

Linnæus gave the name of nectary [3] to certain parts of the blossom, which he could not understand, such as the spur [4] in larkspur, columbine, and snap-dragon, and the scale [5] on the claws of the petals, as in butter-cup, said by Professor Lindley to be "a barren stamen!" It would be better to abandon this erroneous term, nectary, the part so called having often nothing to do with secreting or storing up honey.

The Stamens.

Immediately within the blossom, when there is a blossom, there are from one to many small bodies, varying considerably in size and form, which are termed stamens [6], and are considered to be the male organs of

(1) In Latin, *Corona*.
(2) In Latin, *Orbiculus*.
(3) In Latin, *Nectarium*.
(4) In Latin, *Calcar*.
(5) In Latin, *Nectarostigma*.
(6) In Latin, *Stamina*.

reproduction. A stamen consists in most cases of a filament[1], usually white; and always of an anther[2], usually yellow or purple, composed of two lobes with a furrow between them, as may be seen in sage and balm, containing small fructifying grains termed pollen. M. Duval has shown that the stamens are always next to the petals; that is, between their base and the base of the seed organ; and that botanists are therefore wrong in saying they are inserted into the flower-cup, the blossom, or the pistil, even when they obviously are thus inserted.

Stamen.—*a*, the filament; *b*, the anther.

The number and arrangement of the stamens are of indispensable utility in systematic arrangements, as will be seen when we come to the systems of Linnæus and Jussieu.

The Disc.

Between the base of the filaments of the stamens and the seed organ we often find an expansion, which Linnæus called a nectary, as he did every part of a flower which he could not understand. We may call

(1) In Latin, *Filamentum*. (2) In Latin, *Anthera*.

this the disc [9], because it is usually round, though it is often lobed and gland-like, as in the protea and the rose; cup-formed, as in peony and waterbane; covering the summit of the seed organ in carrot and hemlock; like bundled stamens tipt with glands in grass of Parnassus; coming between the style and the seed organ in composite flowers; joined with the receptacle in borage, and adhering to the sides of the flower-cup in the almond.

The Pistils.

In the centre of the flower, and always surrounded by the disc when there is one, and when none by the stamens, there may be observed from one to many small bodies, varying much in length and form, termed pistils, and considered to be the female organs of reproduction. A pistil [2] consists of a style [3] and a summit [4]; and at the base of the style we find the seed organ [5], which will fall to be described afterwards. The summit, like the spongelets of roots, is never covered by the rind, as all other parts of a plant are, and hence what is termed the summit by Linnæus in the iris, the sweet pea, and in labiate flowers, is really the style.

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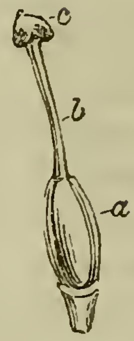
(1) In Latin, *Perigynium* (LINK), or *Discus* (LINDLEY).

(2) In Latin, *Pistillum*. (3) In Latin, *Stylus*.

(4) In Latin, *Stigma*, which is not very appropriate.

(5) In Latin, *Ovarium*, by modern writers; by Linnæus, *Germen*.



Pistil, with Seed Organ.—*a*, the seed organ ; *b*, the style ; *c*, the summit.

The number and form of the pistils is important in systems. The structure will be explained in a subsequent page.

FABRIC OF PLANTS.

Having thus given an account of the external members of plants, I shall next direct the beginner's attention to their whole fabric or structure, from the rind and bark to the central pith; an important part of science altogether neglected by Linnæan botanists; in the same way as the texture of animal bodies was neglected by anatomists, previous to the time of Baron Haller, and M. Bichat.

As an animal body, then, is composed of solids and fluids, the solids consisting of cellular, nervous, muscular, and horny tissues, and the general fluids of lymph and blood, besides the peculiar fluids of bile, milk, and others; so the body of a plant is also composed of solids and fluids, considerably different from those of animals. The solids, as I shall now detail, consist of three tissues, one composed of cells, another of fibres, and a third of vessels.

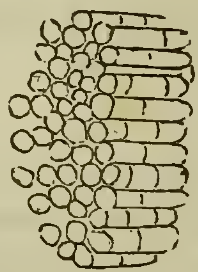
TISSUE OF CELLS.

As the great mass of an animal body is made up of flesh, often depending for support upon bones; so the great mass of a plant, from the tiny wall moss to the giant oak, is made up of a texture or tissue of cells[1],

(1) In Latin, *Tela cellulosa* or *Textura cellularis*, formerly *Parenchyma*.

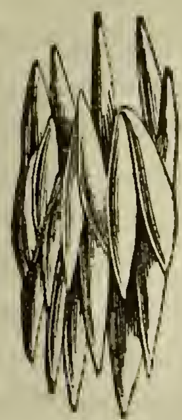
which may be described as a number of bags, bladders, or vesicles, as they have been variously termed, of different forms and dimensions, united together; the whole being sometimes loose and spongy, sometimes close and hard, and sometimes spread out into thin pellicles with scarcely a trace of the cells observable.

M. Mirbel compares the structure of this tissue to that of the froth of soap suds; but it differs from this in the partitions being always double, though Link thinks the cells are originally formed, like froth, by the expansion of gas. Each cell is closed all round, without having any inlet or pores, so far as can be ascertained, though fluids certainly pass into the cells, as may be seen on slightly pressing the flower-cup of lettuce, when a milky fluid will ooze out. The pores in the cells, which M. Mirbel supposed to exist, have been proved by M. Dutrochet, to be minute grains sticking to the sides of the cells.



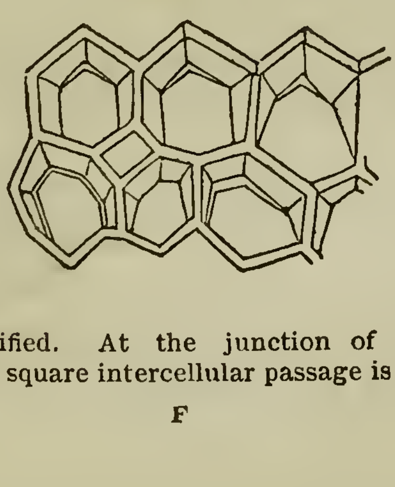
Globular cells magnified from the leaf of *Lantana aculeata*.

If Link's notion of the origin of the cells be correct, they must all be globular, and their various figures differing from this form, must arise from the globules being variously compressed. In several instances, the cells are oblong, as in the roots of parsley.



Oblong cells from the bark of a kidney bean magnified.

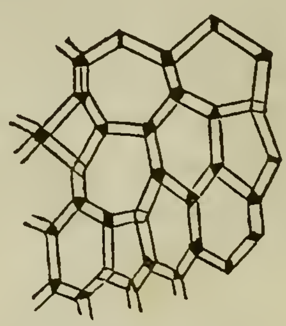
Compression of a different kind produces twelve-sided figures, which, on being cut across, appear to be six-sided, like a honeycomb; as may be seen in a thin slice of alder pith and in the bark of many plants.



Six-cells magnified. At the junction of the four cells, towards the left, a square intercellular passage is represented.

Intercellular Canals.

The junction of the cells may be so close, that no interval is perceptible; but it is often not so, and a space is left, varying in size and form in different plants. This space is termed an intercellular passage [1], and is always large in fleshy and juicy plants, as nasturtium, and, so long as a plant is alive, is filled with fluid. M. Link describes a larger interval, which always runs perpendicularly, while the preceding may run in any direction. The perpendicular sort he terms intercellular ducts [2]. Rudolphi and Mirbel deny the existence of these.



Perpendicular intervals, called intercellular ducts, shown in the black squares between the cells of swine thistle.

In these passages Rafn discovered small transparent needle-shaped substances [3], whose use is not known.

(1) In Latin, *Meatus intercellularis.*
(2) In Latin, *Ductus intercellularis.*
(3) In Latin, *Raphides.*

TISSUE OF FIBRES.

While the tissue of cells, just described, may be said to resemble the flesh of plants, the tissue of fibres [1] may be said to resemble the bones, though plants have not anything exactly corresponding to animal bones. The fibres are not always interior like bones, but are found in bark; and to this, indeed, grasses and other slender plants owe their stiffness. A good example of the tissue of fibres may be seen in the bark of flax and hemp, which is the part made into cloth and cordage. Du Hamel fancied these fibres could be divided into finer and finer ones without end; but the smallest are only about one sixth less than that of a human hair.

All the fibres are tapering, transparent, and allow fluids either to pass through them or between them. They are not composed of cells, as some erroneously state.

This tissue composes all the woody part of plants and trees, and is found of course in the ribs of the leaves.

The Straight Vessels.

It appears to me that what I have just described as fibrous tissue, has been frequently termed the straight vessels, of which various accounts are given.

Grew describes these as straight hollow threadlets,

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(1) In Latin, *Tela fibrosa;* inaccurately, *Vasa fibrosa.*

fifty times finer than a horse hair, forming a larger tube, as if we should suppose a walking cane composed of small straws, as in the following figure.

Leuwenhoeck describes them as composed, like the quills of birds, of two transparent tissues, one placed lengthways, and the other across, with no lateral communication.

Hill tells us that some of these vessels collapse when emptied of their contents; and though he fancied he had discovered cells in them, these turned out to be only globules of fluid. He says they communicate with the cellular tissue by minute mouths.

M. Mirbel, reverting, as it should seem, to the opinion of Malpighi, describes all the vessels of whatever form, as cells variously developed, with pores in their sides; a fanciful notion which he exults over as original.

Pores of Tissue.

As to the existence of pores or openings in the sides of those vessels, Malpighi supposed them to be only imperforate elevations.

Hooke says there is much more difficulty in discovering the true nature of such minute objects with the microscope, than with the naked eye, and in distinguishing between a perforation and a transparent point.

Kieser thinks that under a very highly magnifying power, he has in some vessels detected the existence of pores.

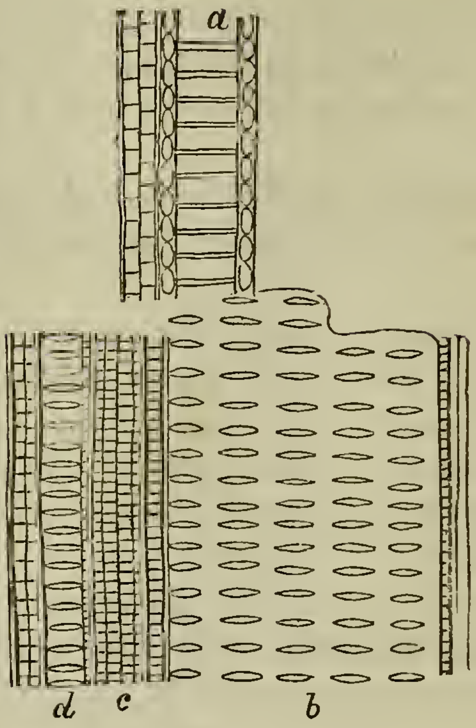
M. De Candolle suggests the probability of these supposed pores being small glands, destined in some way to contribute to the nutrition of the plant.

M. Mirbel describes them as similar to the pores in the outer bark, being furnished at their orifices with a bulging border.

M. Amici agrees with this observation, and hence concludes, that the pores are not for the transmission of fluids, but of gases, evolved in the interior of the plant.

M. Dutrochet again denies the existence of the pores, which he says are globular cells, filled with green transparent matter, the supposed hole in the centre being an optical deception. He ascertained that, by boiling the parts supposed to contain pores, in hot nitric acid, they were rendered opaque; and again, upon neutralising the imbibed acid with caustic potass, their transparency was restored—a change incompatible with perforation.

M. A. Richard, on the other hand, thinks Dutrochet is entirely mistaken, and that, having overlooked the real pores, he has described what M. Turpin has recently termed globuline.



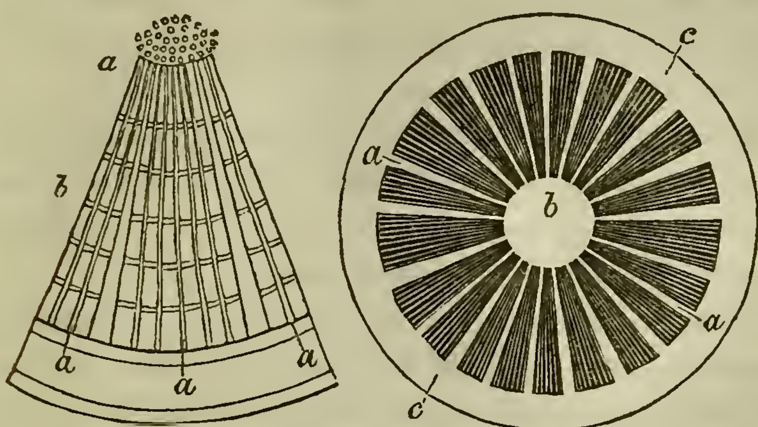
Slice from the root of the date tree, magnified.—*a*, straight tube; *b*, modified vessels or air-tubes of Link; *c*, straight vessels; *d*, air-tube of Link.

The Silver Grain.

The beginner must take care not to confound with the fibrous tissue, which runs perpendicularly, those woody rays running out from the centre of trees, and termed by carpenters the silver grain[1]; for though this gives firmness to the plant as the fibres do, it is wholly composed of cellular tissue, which has been

(1) In Latin, *Radii medullaris.*

pressed into this form by the sap arising between the pith and the bark. The silver grain appears to keep open the communication between the bark and the pith, which the formation of the wood would otherwise have separated.



Slices of plants, magnified—*a*, *a*, the bark; *b*, *b*, the pith; *c*, *c*, rays of the silver grain.

TISSUE OF VESSELS.

If the opinion of Kieser, Link, and some other high authorities, be correct, that the fibres and straight vessels just described, originate in what are termed spiral vessels, it would have been proper to begin with these; but as this is a point still doubtful, though not improbable, I have preferred the present arrangement.

The Spiral Vessels.

These vessels[1] are found coiled up like a corkscrew; or rather resembling a wire as small as a hair wound

(1) In Latin, *Vasa spiralia*; by some, *Tracheæ*.

spirally round another, and the latter withdrawn. They all end in a conical point. The spiral vessels exist singly or in bundles in every part of a plant, from the root to the petals, except the bark, constantly accompanying and ensheathing the straight vessels or fibres. They may be seen in the form of fine gossamer, by gently pulling asunder the stalk of a strawberry leaf or a young shoot of dogwood.

Malpighi found that they were not separable into rings, but could be drawn out to a great length, and that they are formed every year in the pulp-wood, immediately within the inner bark.

Grew found that they alternate with the straight vessels, in every part of the wood, and surround and ensheath them in the leaf-stalk, the leaf, the flower, and the fruit. While the straight vessels are formed in spring, the spiral vessels are formed in summer.

Du Hamel, upon their structure appearing similar to the rings of the windpipe, supposed that they convey air, though he found sap in them during autumn.

Hill says they contain a limpid fluid at midsummer, and in autumn, but at other seasons are empty.

Reichel proved by growing plants in coloured fluids, that the spiral vessels exist in every part except the bark and the pith, everywhere conveying nutritive matter, and not air.

Hedwig in some measure combines the above conflicting opinions, by describing a spiral vessel as composed of a membranous canal for conveying air, and a spiral tube rolled round it for conveying fluids.

Mirbel and De Candolle seem to support the notion of Du Hamel, that the spiral vessels are air tubes.

Treviranus and Bernhardi distinguish several sorts of these spiral vessels, which may probably serve different purposes.

Kieser, most originally and ingeniously following the suggestions of Grew, attempts to demonstrate, from numerous observations on the gourd, that the variations in the form of the straight and the spiral vessels, arise in the different progressive stages of growth.

In the first stage they are of two forms: simple, constructed of one or more contiguous fibres, twisted round an empty space; and ringed, or consisting of a series of rings, disposed in a perpendicular line. "The turns," says Link, "of the tube become mutually detached; the rounds become more slender; and intervals[1] are formed which are never seen in young plants. There are no porous tubes, such as are described by authors, nor are there pores either in the vessels or the cells. Often what are said to be pores are nothing more than the remains of a spiral tube; nor are there pores either in the vessels or the cells. Frequently what are alleged to be pores are nothing more than the remains of a spiral tube, or of small bulgings thereof, remaining permanent, when the spiral character has disappeared."

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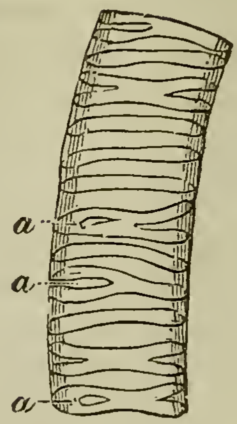
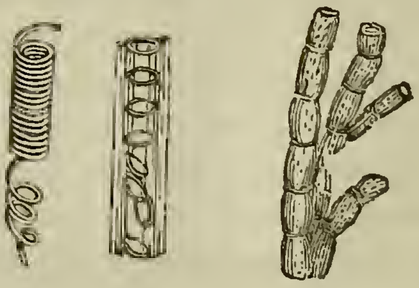
(1) In Latin, *Lacunæ;* objectionably, *Pseudo-tracheæ.*



Doublings of spiral vessels in the balsam plant.—*a, a, a,* remains of the doublings in form of pores.

" The annular vessels [1] again, first described by Bernhardi, are altogether different; being produced by the rounds of a spiral tube becoming at first detached and again united, to form a ring. The beaded vessels [2] are only spiral vessels turned or folded with narrowings at the foldings."



Spiral, annular, and beaded vessels, magnified.

(1) In Latin, *Vasa annularia.*
(2) In Latin, *Vasa moniliformia.*

THE FLUIDS OF PLANTS.

The animal fluids consist principally of what is digested in the stomach, and formed first into a pulp called *chyme*, and then into another termed *chyle* ; and secondarily of this chyle converted into blood, which in its course gives off bile, urine, and other fluids. The fluids of plants however are not so distinctly marked, and it is greatly owing to this that so much uncertainty and confusion prevail among even the best authors.

To the first fluid which is met with in plants, and introduced in whole or in part immediately from the soil, I give the exclusive name of sap [1]. It is usually a clear, thin fluid of a pleasant taste, composed chiefly of water, carbonic acid gas, and nitrogen or azote [2]. To the second fluid, analogous to blood, often confounded in books with the sap, and composed of the sap deprived of much of its water and of the oxygen of the carbonic acid gas, I give the exclusive name of pulp [3].

There are other peculiar fluids, such as oils and acids, found in plants, whose formation and use are little understood.

Having thus briefly gone over what may be called the simpler elements of all plants, I shall next take

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(1) In Latin, *Succus*.
(2) See ALPHABET OF SCIENTIFIC CHEMISTRY.
(3) In Latin, *Cambium*.

notice of the parts in which these tissues and fluids are peculiarly combined, beginning with the bark, and going inwards through the wood to the pith.

THE SKIN, OR RIND, OF PLANTS.

In animals, the outer skin, which is that raised up by a blister, has no more feeling than the nails or the hair, and is therefore intended to sheathe and protect the more sensible parts beneath.

In plants there is a similar outer skin, commonly termed the rind[1], intended, no doubt, for a similar purpose, though this is not so well understood as in animals.

Excepting the spongelets of the roots, and the summit of the pistil in flowers, the rind covers every part of a plant, from the tips of the roots to the edges of the leaves and flowers, but varies much in thickness both on the same plant and among different species. It is very thin and delicate on flower leaves or petals, as well as on leaves, young shoots, and mosses; while on old stems and branches, it is either composed of a considerable number of layers, as in the birch; or very thick, as in the cork-oak—the cork being the rind.

As the scarf skin of the human hand becomes thick and rough by hard labour, so does the rind of trees exposed in a field to all weathers; while the rind of the same species sheltered by surrounding trees in a

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(1) In Latin, *Cuticula*, or *Integumentum cellulare;* in Greek, Επιδερμις.

wood, like the skin on the hands of a delicate lady, remains thin and smooth.

As plants increase in thickness, the rind is stretched out to make room for the addition, as in the apple tree; and in some fruits, such as the giant pear and the pumpkin, this stretching out is considerable. In other cases, such as on the trunks of the oak and elm, the rind not being sufficiently stretchable, cracks into many pieces; while in other cases still, such as on the trunks of the currant, the sycamore, and the birch, the rind peels off every year, and a fresh one is formed, as is the case with the outer skin in serpents.

On flowers, leaves, and young branches, where the rind is thin, it is usually transparent and colourless, the colour which is seen being that of the inner bark shining through it, as may be observed on the leaves of oak, rose, bramble, holly, or sorrel, mined out under the rind by minute caterpillars[1]; but when it is thick on the roots of trees it is usually coloured brown or grey.

Many various opinions have been held respecting the origin and structure of the rind.

Malpighi held that it is not a distinct membrane, but is continuous with the bark.

Hill and Mirbel, adopting a somewhat similar opinion, think it is formed from the outer sides of the cells composing the bark beneath it; but they are obliged to suppose many plants, where this is not observable, to be destitute of rind.

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(1) See Insect Architecture, p. 233.

Grew seems to have held a somewhat different opinion, and describes it as a separate membrane composed of minute cells, or, as he terms them, "bladders," which shrink and are dried up as the plant grows older.

Du Hamel denies the existence of the cells described by Grew, and says the rind is composed of fibres across the trunk, and that these in the birch are connected with other lateral fibres.

Comparetti also describes it as formed of fibres, interwoven with six-sided meshes, with vesicles between filled with air.

Desfontaines says it resembles thin parchment, with numerous pores extremely minute.

Kieser, who studied the rind with great care, comes nearly to the same conclusion as Grew. In a species of fern, he found a network of vessels by which the rind, as he thinks, is formed.

Krocker again thinks Kieser was mistaken, his supposed net-work vessels being nothing more, he says, than the sides of the cells beneath; and Krocker is supported in this by Jurine, Mirbel, Sprengel, and Link.

Saussure, the elder, describes the rind as formed of a very thin outer skin, full of very minute pores, and beneath it a very delicate net-work of vessels.

Bauer describes the rind as cellular, and as varying considerably in different species of plants.

De Candolle describes the rind to be in certain parts a simple membrane, and in other parts to be formed of layers, composed of cells. In the young state it is most easily torn lengthwise, because it grows in this manner, but, when older, it is most easily torn across, because the cells[1] (or what Guettard terms glands[2]) stretch out in that direction.

Professor Amici, by means of his powerful microscope, has recently supported the opinion of Grew, finding the rind perfectly distinct from the layer beneath it, and composed of a simple layer of cells or vessels[3] extremely variable in form in different species. Were these cells continuous with those beneath, as Malpighi and Michel maintain, they ought to have the same form, which is not the case; for in the pink and other plants the cells of the rind are square, while those beneath are in form of tubes placed perpendicularly.

There has, in some instances, been found a very delicate, transparent, and apparently unorganised membrane on the outside of the rind. Professor Henslow observed this in the foxglove oak; Adolphe Brongniart in the leaf of the cabbage.

Pores of the Rind.

The pores[4], or, as some term them, glands[5], of the rind, successively supposed and denied by authors, have been incontestably proved by Amici to be a sort of minute bags, opening on the outside by an oval slit

(1) In Latin, *Lenticellulæ.*
(2) In Latin, *Glandulæ lenticulares.*
(3) In Latin, *Vasa lymphatica.* (4) In Latin, *Stomata.*
(5) In Latin, *Glandulæ cutaneæ.*

with a raised border, which contracts when water or moisture is applied, and expands in dry air or when exposed to sun-light. At the bottom of these pores are spaces full of air mutually communicating. The same view is taken by M. Adolphe Brongniart in his splendid paper on the anatomy of leaves.

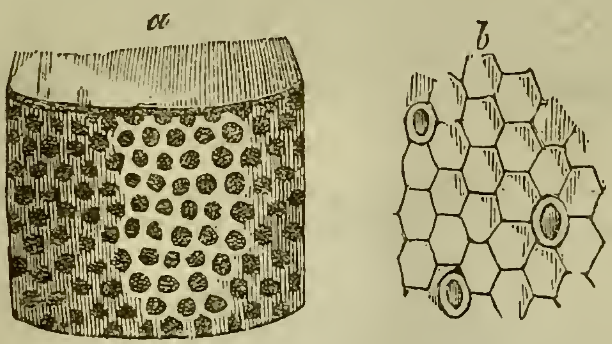
No pores have been hitherto detected, even by Amici, in roots, old stems, seeds, fleshy fruits, petals, or blossom leaves in general, or in any water-plants. Some leaves again have pores on both surfaces, others only on one, and that chiefly the under surface.

In the water crowfoot there are pores only on the upper surface of the floating leaves; none in the leaves under water. A leaf of green mint has no fewer than 1800 pores on its under side: but after it is placed so as to be under water for a month, it falls off, and the new leaf that succeeds has no pores. When water-plants again are forced to grow in a dry place, they acquire pores. Blanched plants have no pores.

Rudolphi found the largest pores on the leaf of the white lily; the smallest on the leaf of the French bean.

Richard thinks it probable that the pores are intended to afford a passage to the air, either outward or inward, or both; though, from their being always shut at night, when the leaves absorb the carbonic acid gas dissolved in dew, it is probable their chief office is to give off oxygen by day—an opinion corroborated by the petals of flowers, which do not give off oxygen, being without pores.

It may be proper to state, that Link and Nees von Esenbeck, deny the existence of any perforation in these pores, which are covered, they say, with tissue. R. Brown, again, describes them as glands whose disc is perhaps sometimes perforated.

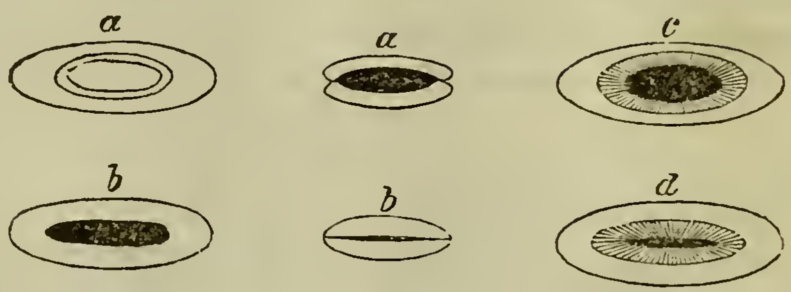


Pores.—*a*, portion of the surface of a walking cane; *b*, a portion of the epidermis or outer skin, with three pores placed among the meshes; both figures greatly magnified.

Air Cells.

The pores lead to small cavities which have been termed air cells, very variable in size, figure, and arrangement. M. Dutrochet, by putting leaves under water in the exhausted receiver of an air pump, observed the water forced into the cells. He thus proved that the white colours of flowers as well as the spots on leaves are caused by the superabundance of these air cells. Similar cells may be seen in the stem of the rush placed one above another, and separated by membranous partitions.

It confirms the preceding opinion that the structure of the pores is so very similar to that of the spiracles or breathing pores of insects, as may be seen in the following comparative figures.



Pores : *a, a,* pores of plants open ; *b, b,* the same shut ; *c,* breathing pore or spiracle of an insect open ; *d,* the same shut.

The Coloured Rind.

Immediately under the outer rind, which, as I have said, is often transparent and colourless, there is a layer [1] composed of small cells, among whose interstices coloured globules are dispersed. In young stems and leaves it is commonly of a green colour. In young branches it is the green bark immediately beneath the rind.

This, according to Dutrochet and other authorities, performs very important functions, as we shall afterwards see.

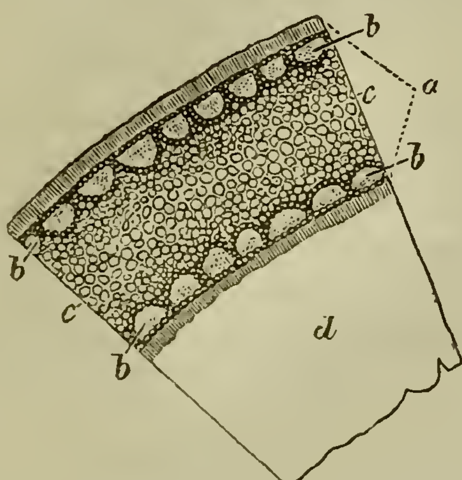
THE INNER BARK.

THE bark [2], exclusive of the rind, consists of two layers, which cannot however be always distinguished.

(1) In Latin, *Integumentum herbaceum.*
(2) In Latin, *Cortex.*

The first or outermost is formed of sets, or bundles of vessels, at first straight and mutually parallel, but afterwards separating, except at a few points, as is beautifully seen in the lace tree; where they resemble woven cloth, or rather very regular lace work.

In the fresh shoots of trees, which are produced yearly, only a single ring of vessels is observable, which then constitutes this layer, before there is any other formed.



Vessels of the Bark.—Slice from a plant, greatly magnified.—*a*, bark; *b*, *b*, rings of vessels; *c c*, pulp bark, with its cells; *d*, the wood.

Within this a fresh layer of similar net-work vessels is formed, while the former becomes more hard and firm. In the same manner additional layers are formed, and the whole series of these, excepting the outer one, is considered the second coat [1] of the inner bark.

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(1) In Latin, *Liber*, which is not very appropriate in most cases.

These different layers are usually separated by a thin layer of cellular tissue, which is partially dissolved by steeping in water, when the layers may be separated; otherwise this is seldom practicable.

The soft pulpy mass immediately within this inner layer, I beg leave to term the pulp bark, when it is at any time required to distinguish it.

This portion of the bark is very important in the economy of vegetation, as will afterwards appear.

Terms applied to Rind.

The rind of plants varies much in the aspect of its surface. Sometimes it is shining [1] as if varnished; sometimes smooth and bare, without hair or down [2]; and again smooth without inequalities [3]. It may also be rough [4] like shagreen; coarsely rough [5]; warty [6]; pimply [7]; scored or grooved [8]; furrowed [9]; glutinous [10]; or clammy [11].

THE WOOD OF PLANTS.

The solid mass of plants which is within the bark, is in trees, shrubs, and other ligneous plants, termed wood [12]. It is composed chiefly of the tissue of fibres

(1) In Latin, *Nitidus*.
(2) In Latin, *Glaber*. (3) In Latin, *Lævis*.
(4) In Latin, *Scaber*. (5) In Latin, *Asper*.
(6) In Latin, *Verrucosus*. (7) In Latin, *Papulosus*.
(8) In Latin, *Striatus*. (9) In Latin, *Sulcatus*.
(10) In Latin, *Glutinosus*. (11) In Latin, *Viscidus*.
(12) In Latin, *Lignum*.

already described, and the compressed cells termed the silver grain.

Immediately within the pulp bark, when that can be distinguished, there is frequently another pulpy layer placed over the hard wood or heart wood, which I shall term pulp wood [1].

The whole wood of a tree is made up of concentric layers, each of which is the growth of one year; and hence upon cutting a tree across and counting the annual layers or rings of wood, its age may be pretty nearly guessed, if not quite ascertained.

THE PITH OF PLANTS.

THE pith [2] is what is popularly termed the *heart*, because it occupies the centre. It is with few exceptions composed exclusively of cells, rather loose in texture, as in the elder, or compact, as at the nodes of the ash.

The pith is contained in a cylindrical sheath, termed the pith tube [3], which, when once formed, is said by Turpin and others never to alter its dimensions. Projections of this pith tube go off to every bud and branch formed on the plant.

In hemlock, cow-parsnep, and other plants with hollow stems, it is the centre of the pith which is hollowed out.

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(1) In Latin, *Alburnum*.
(2) In Latin, *Vagina medullaris*.
(3) In Latin, *Medulla*, which is inaccurate.

ORGANS AND FUNCTIONS OF PLANTS.

The preceding brief descriptions of the external parts and members of plants, and of their general fabric, external or internal, will prepare the beginner for entering upon the study of the organs destined for the digestion of food, for circulating and aërating the fluids thence introduced, and for reproduction,—subjects which the botanist usually leaves to the vegetable physiologist, but which ought, as I think, to be always considered as a leading branch of botany.

ORGANS OF DIGESTION.

As plants cannot, like animals, move about in quest of food, it is necessary that what they require should be very generally diffused and commonly met with, and that they should have organs adapted to take it up as nourishment, and convert it into pulp, and thence into bark and wood, in some such way as animal food is converted into blood, and thence into bones, muscle, and gland.

Food of Plants.

The food of animals always consists either of other animals, of vegetables, or a mixture of both, together with water, or some fluid containing a considerable proportion of water, for drink: that is, as a solvent to the more solid matters. Plants again, strictly speaking, subsist on drink alone, being indeed incapable of taking up any solid matter, at least till it be previously dissolved or diffused in water.

There is an obvious and well-known proof, that plants live in water chiefly, if not altogether, derived from hyacinth and other bulbs placed in glasses, and supplied with water, in which they blow as well as in a garden. It is found, however, that they do not thrive unless the water is regularly changed, indicating that it is not the water alone, but something in the water, which becomes exhausted and deteriorated by the feculent slime discharged by the plant. It has also been found by experiment, that distilled water will not support a healthy growth in plants, and most, if not all species, when planted in pure calcined sand, and watered with distilled water, quickly die, as they do when quite deprived of water.

From chemical analysis and experiment, it appears that the chief matters taken up by plants, besides water, consist of carbonic acid gas and azote, or nitrogen, chiefly in form of humic acid, together with a few salts, such as potass, and out of these and the hydrogen and oxygen of the water, all vegetable products seem to be wholly or chiefly elaborated.

M. Lassaigne proved that these all pass into the plant from without, by the ingenious experiment of analysing the chemical constituents of seeds before and after germinating.

When by chemical experiment substances are found in plants different from those supposed to have been introduced from the soil, it is not to be inferred that the plants have created these, but that they have gradually taken them up in very minute portions till a considerable quantity has been produced.

It is proper to confess, however, that we are still much in the dark upon this interesting subject, it being extremely difficult, if not impossible, to trace the fluid taken up by a plant after it passes beyond the surface.

The Spongelets or Suckers.

We have elsewhere seen that many insects support themselves wholly by suction [1]; and we now remark that all plants do the same. For this purpose, they are furnished, not with a single sucker, like the leech or the flea, but with many. De Candolle describes these suckers, which he terms spongelets [2], as resembling a minute sponge, full of pores, inferred, when they cannot be detected, from the fact of fluids actually passing into them. The spongelets are always placed on the extreme tips of the rootlets or smallest fibres of the root, and are composed of an expanded tissue of small roundish cells, often as soft as pulp.

It is important to remark, that the spongelets will not admit any fluid much thicker than water, and accordingly when plants are watered with the drainings of the farmyard in an undiluted state, the pores of the

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(1) See ALPHABET OF INSECTS, p. 60.
(2) In Latin, *Spongiolum*.

spongelets are obstructed, and the plants are suffocated, or rather perish of famine in the midst of plenty.

The spongelets will not in any case admit of the smallest particle of a solid substance. Sir H. Davy mixed with water some charcoal so finely powdered as to be impalpable, in a phial where a plant of peppermint was growing. During a fortnight the plant grew vigorously; yet on cutting the roots in different parts not a trace of a black powder could be detected.

Though the spongelets of the roots, however, are in most cases the main inlet of nourishment to plants, there are also suckers in other parts, particularly on the under sides of the leaves of trees, for when Bonnet and Du Hamel placed leaves with their under sides on water they kept long green, while they soon withered when placed on their upper sides. But this might be from the evaporation of their leaf pulp being prevented, as much as from moisture sucked up.

Plants deprived of their regular supply of carbonised water, have resources which are very remarkable. Thus a shoot cut from a tree and either end planted, will take in water at the cut ends of its vessels, till new rootlets furnished with spongelets are formed. Upon this is founded the practice of propagating plants by cuttings [1].

The root, however, is the regular organ, and when a leaf or the cut end of a shoot in the process of striking,

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(1) This is further explained in the ALPHABET OF SCIENTIFIC GARDENING, p. 72, &c.

sucks in nourishment, the pores there may be considered as analogous to the pores of the skin or of a raw surface, in animals, which act similarly, but are not therefore considered to be mouths.

Hales found that a pear-tree weighing seventy-one pounds, sucked up fifteen pounds of water in six hours; and branches about an inch in diameter, and five or six feet high, sucked up from fifteen to thirty ounces in twelve hours; while the same branches, if stript of their leaves, only sucked up one ounce in twelve hours. A plant of mint, whose roots Hales plunged into a bent tube with water, made it fall an inch and a half during the day, but only a quarter of an inch during the night; while a hop plant sucked up four ounces in twelve hours when in a shady place, and eight ounces in a place more open.

By watering a plant with coloured fluids sufficiently thin to be taken up by the spongelets, their course has been traced up through the plant, in the form of sap; and from the composition of this sap, it is obvious that the chief food of plants consists of carbonic acid gas, and azote, often in the form of humic acid [1], dissolved in water and diluted before it passes into the spongelets, consequently the water holding the most of these gases, which are the real food of plants, must be the best for vegetation. This shows the reason why rain and river water, which have most opportunities of being impregnated with these gases, are better for watering with than the stagnant water of pools or

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(1) See Alphabet of Scientific Gardening, p. 12.

lakes, and still better than that of springs and pumps; and why watering from a garden pot with a very finely perforated rose is more advantageous than from one with coarser holes.

Hence also we discover the principles of manuring, the fresh dung of animals being bad till it is fermented and rotted, in order to form humic acid, which is also accomplished by ploughing in green vegetable crops, by burning the soil, by scattering ashes or quicklime, or mixing the latter in compost heaps. The mere mixture of soils and frequent ploughings proposed by Kretschmar, by Tull, and lately by Mr. E. Lance, therefore do not succeed, as might have been foreseen; for these will not supply the gases wanted.

It is on the same principle that soil overshadowed with thick leaves is good, from its attracting carbonic acid vapours, and preventing their escape. Hence a crop of potatoes, turnips, or vetches fertilises, while corn and flax exhaust, the soil, and hence corn thrives better when clover is sown with it. On this, and on the fact of plants throwing out excrementitious matter into the soil, is founded the practice of the rotation of crops [1]. Volcanic and basaltic countries, from the soil containing much carbonic acid gas, are always very fertile, even where the earth is very shallow, as is every where seen in the vineyards on the Rhine, and in Sicily, and near Naples. The basaltic carses of Scotland are famous for fertility.

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(1) This subject will be more fully explained in the ALPHABET OF SCIENTIFIC AGRICULTURE, now in preparation.

Digestion.

Plants having no common gullet, have moreover no common stomach for the digestion of food, and all the researches hitherto made respecting the conversion of carbonised water (if I may thus term the sap) into the fluids peculiar in smell, taste, and colour found in the plant, have only led to plausible conjecture. Some observations render it not improbable that, on the first imbibition of the carbonised water by the spongelets, it may be in part mixed with some other fluid from the interior of the plant, in a similar manner to the food of animals being usually mixed with saliva in the mouth; and though this may not be sufficient to convert the sap into fluids of different character, it may, like the animal saliva or the digestive fluid in the stomach, greatly assist such conversion.

ORGANS OF CIRCULATION.

What is popularly termed the *heart* (properly the pith) of plants, has no resemblance whatever to the organ termed the heart in animals, which is the central reservoir for receiving the blood, and again propelling it to all parts of the body. In plants there is no organ in the least resembling such a heart; yet the fluids, notwithstanding, circulate both upwards and downwards, often with great rapidity and with considerable force. On this subject various opinions are, and have been, held.

It has been the most extensively received notion, that the sap rises in peculiar vessels by the combined influence of what is termed capillary attraction and of heat, in the same way as water will rise to a certain height in a glass tube with a capillary bore, that is of the diameter of a hair; but it is fatal to this explanation, that fluids will not rise in the capillary vessels of dead plants.

Plants seem to be equally indifferent as to the quality of the fluids which they suck up from the soil; and will as readily take a poisonous as a nutritious one, provided it be equally thin and not viscous.

Grew explained the rise of the sap by magnetic attraction.

Malpighi and Borelli referred it to the contraction and expansion of internal air, and of the juices by heat.

Du Hamel imagined the whole to be referable to the influence of heat.

Saussure, Mirbel and T. A. Knight refer to the irritability of the vessels, and to what they term the vital force.

De La Hire referred it to organisation, and supposed the return of the fluid was prevented by valves, which, however, have not been seen.

Perrault imagined it to proceed from some sort of fermentation.

De Candolle supposes that the nutritive fluids are taken up from the soil by the spongelets on the same principle[1] that water runs through blotting paper, or rises up into a piece of loaf sugar, from getting between

(1) Technically, *Hygroscopicity.*

the minute cells. He fancies (for it is quite a fancy) that every cell has the power of alternately expanding and contracting, and by that means the fluid, not in the cells, but between and among them, is pushed along. It is thus carried up, not in any sort of vessel, but between the cells directly to the leaves, without undergoing any other change than that of mixing with the juices it may meet with in its course.

Professor Henslow says "the particular route which the ascending sap takes, has often been matter of dispute, but it has been clearly ascertained by repeated experiments, that it ascends along that portion of the cellular tissue that constitutes the woody fibre and not through the vascular tissue; with respect to the mode in which this sap is conducted along this cellular tissue, there is still much uncertainty."

Dutrochet explains it on the principle of experiments made in 1827-8, with various membranes. He filled with milk the large gut of a fowl, tied it at each end, and placed it in water, when in twenty-four hours he found seventy-three grains of the water had got through and mixed with the milk, and in twelve hours more the gut became tensely swelled out with water. But what was remarkable, the passing of water after that time was reversed, and in thirty-six hours fifty-four grains had oozed outwards. By filling the gut with a solution of gum arabic, inserting in its upper orifice a glass tube, placed perpendicularly, and plunging the other tied end into rain water, the water, by passing in, forced the thicker fluid up through the glass tube. He thence concluded that a thinner fluid will in all cases pass through a thin membrane into a thicker fluid: and in all such cases there will be, according to circumstances, an inflow [1], or an outflow [2], depending on electrical agency. It is upon this principle that he thinks the spongelets in the root, containing a fluid thicker than the carbonised water in the soil around them, imbibe it and force it up to the tops of the highest trees.

Hales cut off in the spring the branch of a vine, and enclosed the cut surface of the stump in a bent tube, when the sap flowed so abundantly and with such force, as to sustain thirty-eight inches of mercury, equal in weight to a column of water forty-three feet high, which indicates a force five times greater than the current of the blood in a horse. The fresh cut branch of a vigorous pear-tree, he found, raised the mercury eight inches in six minutes. Bonnet, in experimenting upon blanched plants with coloured fluids, found that these rose within the plants from two to three inches in an hour.

That heat is a main agent in raising the sap is proved by the experiment of placing in two similar vases of water, two similar vine plants, leaving the stem of one in the open air, and introducing the stem of the other through the glass into a hot-house: in the latter the buds will soon expand, and the water become rapidly exhausted; while in the other, the buds will swell slowly, and the water will be slowly diminished.

During the day also, and particularly when the

(1) In French Greek, *Endosmose.*
(2) In French Greek, *Exosmose.*

heat is greatest, the rise of the sap is most rapid, there being a stop, if not a retrograde movement, during the night. Cloudy weather will also diminish the ascent, and a gleam of sunshine increase it, on a principle to be immediately explained.

Experiments and Researches on Circulation.

M. Corti, in 1775, discovered by means of the microscope, a movement in the fluids of stonewort [1] which the Abbé Fontana considered to be a species of rotation. The appearance has again been brought into prominent notice, in 1823, by Schultz and Amici; in 1827 by Meyer; and in 1831 by Dutrochet, Mirbel, and others, who have observed this rotatory movement in water plants, whose textures are transparent, and in land plants with milky juices.

In stonewort and other water plants, the fluids are seen to contain small solid floating particles, usually of a vivid green colour, which are seen to rise till they arrive at a horizontal partition, when they take a horizontal course to the opposite side, and there descend perpendicularly to the bottom of the cell in which they may be, and then cross horizontally to the place whence they started. There are always, of course, motions in four directions; and, what is singular, the motions in each vessel seem independent of those in all the other vessels, and the moving globules are never seen to pass from one to another,—there being indeed no outlet for their passage.

The greater celandine, which has thick yellow juice,

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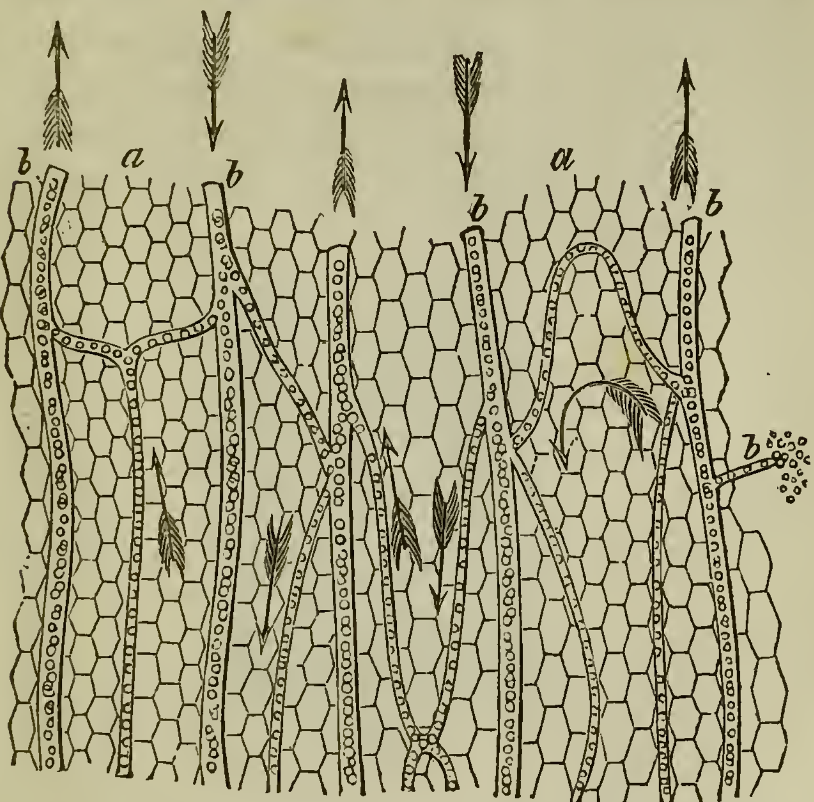
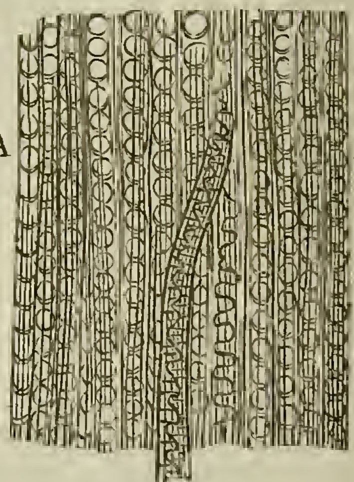
(1) In Latin, *Chara saxatilis.*

and the water plantain, are the plants that have been most commonly selected for examining the rotatory currents. I have taken the following figure of the currents in the water plantain, from M. Schultz.



The arrows show the direction of the currents; *a*, *a*, the cellular tissue; *b*, *b*, *b*, the vessels in which the currents take place, whose direction is pointed out by the arrows.

Professor Link, shrewdly suspecting that the experiments usually performed by watering plants with coloured fluids are inaccurate, in consequence of the colouring matter being only mechanically, and not chemically mixed, had recourse to the ingenious contrivance of producing a coloured precipitate within the plant, by means of two colourless chemical solutions. With this view he watered a plant of *Bigonia discolor* with a solution of the cyanuret of potass and iron, and afterwards with a solution of sulphate of the oxide of iron, when a blue precipitate was produced by these two solutions meeting together within the plant, in the tube of what appears from his figure copied below to be a spiral vessel, and called by him an air tube. No colour was found in the roots.



A, the cellular tissue; B, the vessel coloured blue by the precipitate.

M. Bischoff of Bonn, finding that the interior of a plant was very irregularly and uncertainly coloured in such experiments, discovered that coloured liquids are only sucked up when the air is absent, and he found he could cause the colour to ascend at pleasure, by boiling the coloured water, or otherwise abstracting the air, and the contrary.

Preparation of the Pulp.

As the blood in animals is propelled from the heart to the farthest surface of the skin and of the lungs, so is the sap of plants propelled from the spongelets of the roots to the farthest surfaces of the leaves, where it gives off a portion of its superfluous water, in the proportion of two-thirds, as the animal blood does at the surface of the skin and of the lungs, provided always the pores of the leaves be open; and this depends in a great measure on the presence of sunlight. Consequently, as exhalation cannot take place at night or in cloudy or very cold weather, the sap must accumulate, and its rise must cease, or be greatly diminished.

The watery vapour thus given off may be obtained by enclosing the branch of a vine or other plant in a glass receiver: it is limpid and apparently pure, but putrefies sooner than common water.

The third of the sap, or the portion which remains after the evaporation of the two-thirds, more or less, as just explained, is supposed to undergo other changes in the leaf, though these are not well understood, and under the name of vegetable blood, proper juice, or better, as I think, pulp [1], returns into the body of the plant.

Descent of the Pulp.

Dr. Darwin immersed plants of spurge in red fluids, which he saw rise through the leaf-stalk into the leaf,

(1) In Latin, *Cambium.*

and return white from the edges of the leaf. By similar experiments on the apple and horse-chestnut trees, T. A. Knight traced the pulp from the leaf into the leaf-stalk, and also into the inner bark, through which it probably descends to the root.

The descent of the pulp through the innermost layers of the bark is shown by the experiments of Du Hamel and De Sarabat, who cut a ring of bark from a branch, and found that by thus stopping the descent of the pulp, the upper part extended and healed, while the lower remained stationary.

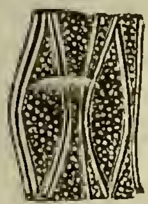
The moving force which causes the pulp to descend, is no better understood than the power which makes the sap ascend.

The Pulp Cells.

As the superfluous nourishment of animals is contained in cellular tissue in the form of fat, in a similar manner, it would appear, is the superfluous or overplus pulp stored up in the cells of plants, or, as Link terms them, cellular reservoirs.

These reservoirs are not uniformly met with, but occur irregularly in the bark, and sometimes in the pith. Malpighi describes them in the bark of the oak and poplar, as containing concrete pulp; and De Candolle supposes the pulp to nestle throughout a plant, in cells, sacs, or reservoirs of various sizes; thus confounding, according to Ellis, the superfluous and extravasated pulp with what is indispensable for nutrition.

M. Dutrochet describes cells of a peculiar kind, of e form of a spindle[1], which he supposes to serve reservoirs for the pulp, and for resin, and other bstances.



Pulp cells.

De Candolle thinks, that gum, which is chemically composed of oxygen, hydrogen, and carbon, is the ultimate form of the pulp stored up; and by slight modifications this gum takes the form of fecula, sugar, and lignine[2], or woody fibre.

ORGANS OF AERATION.

Though plants have no organs analogous to lungs or gills, nor even, I think, to the air pipes of insects, to which the spiral vessels have been mistakenly, it should seem, compared; yet they cannot live without air any more than animals, and they die when deprived of it. The air being thus indispensable to vegetable life, must act on the plant in some manner, and experiments have accordingly proved that the

(1) In French, *Clostre.*

(2) This will be explained in the Alphabet of Organic Chemistry.

leaves of plants perform some function similar to that of the lungs of animals.

In animals, the air taken into the lungs in breathing through the nose and mouth becomes decomposed (in the dark it may be remarked) by giving up part of its oxygen, which combines with the blood, and receiving in turn from the blood a portion of carbonic acid gas and watery vapour.

In plants this process is reversed; for the sap, which has mounted into the leaves and young green shoots, and which is composed of water, carbonic acid gas, potass, and a few other ingredients, either derived from the soil, or taken up on passing up through the plant, becomes partly decomposed in the light; a portion of the oxygen being set free from the carbon, which remains in the leaf while the oxygen is given off into the air, at the same time that the large portion of the water is given off undecomposed, in the form of vapour.

The quantity of water thus exhaled by a cabbage has been proved to be seventeen times greater than that transpired by a man in what is termed insensible perspiration. The exhalation of water takes place through the pores already described of the green parts; but not the decomposition of air, which is effected, as De Candolle remarks, where there are no pores.

It is important to remark that light is indispensable in effecting what may be called the aëration of plants, that is, in decomposing the sap in the leaves, and condensing the carbon, potass, and other matters, indispensable to nutrition, while watery vapour is at the same time exhaled; none of which take place in the dark. Heat may cause a trifling evaporation, but nothing in proportion to that caused by light. It is on this account that plants exposed to much light are greatly harder and tougher than when grown in more shady places: a mountain oak, for example, more than a forest oak; or a wild carrot on an exposed bank, more than a garden one shaded by the leaves of its fellows.

The green colour of leaves, as well as the varied colours of flowers, though very imperfectly understood, may be plausibly explained from the same principles.

Sennebier thinks that the real colour of carbon is dark blue rather than black; while the tissue of the cells and vessels of which the body of plants is composed, is yellow; consequently, when the blue carbon is lodged in these yellow translucent cells, a green colour is the result. Hence, in the spring, the newly expanded leaves, before they have had time to prepare much carbon, are yellowish; and when plants are kept from the light, so that no carbon can be prepared by their leaves, they become white, and also crisp and succulent from the same cause, as is seen in blanched celery and endive.

In autumn, when the leaves assume various tints, it was found by Macaire to arise from their taking in oxygen during the night, and being too feeble to open their pores for its escape during the day. The oxygen thus confined unites with the materials of the pulp, producing various acids, whose known action is to change blues to reds; and consequently, when the blue carbon becomes thus tinged, it produces various shades of orange, and other combinations of red and yellow. Macaire was led by his researches to attribute the various colours of flowers chiefly to oxygen, accumulated in the petals, producing acids to combine with the other principles. It may be well, however, to caution the young beginner not to take these statements for more than an ingenious and plausible theory.

It might be supposed, as plants seem to feed chiefly on carbon, that they would thrive well in smoke, or in an atmosphere of carbonic acid gas; but it is found not to be so, for the particles of carbon in smoke are too large to enter their pores, and too much undiluted carbonic acid gas gorges them, and they will become brown and die.

Plants, it would appear then, are destined by Providence to purify the air, which is loaded, from the lungs of animals, with carbonic acid gas; and to give out a fresh supply of oxygen to replace what is taken up by the lungs.

During the night, however, the green parts of plants take up oxygen, which is retained, and give out a small portion of carbonic acid gas; and hence it is not proper to keep plants during the night in a bed-room. When plants indeed are kept in an atmosphere deprived of oxygen, they soon lose their colours and perish.

Plants can neither germinate nor live in nitrogen or azote, which kills some species almost instantly, though it is often found in small proportions, upon analysing plants. Priestley imagined hydrogen to furnish nutriment to plants, but this has been disproved by experiment.

The decomposition of the air in the lungs of animals evolves heat, but this is less observable in the decomposition of air by plants. Desfontaines found, however, in the cuckoo-pint, that during the formation of the seed the thermometer was raised fifteen degrees[1].

The origin of the various odours given off by plants is no better understood than that of their colours, and I shall not therefore detail mere conjectures[2].

ORGANS OF SECRETION.

In animals, the liver which secretes bile, the breasts which secrete milk, and the kidneys which secrete urine, and similar organs, are termed glands; but though we find in plants numerous peculiar substances somewhat analogous, we cannot always distinguish the glands that secrete these. De Candolle therefore considers every separate cell of the cellular tissue already described, to act as a secreting organ, even when no peculiar glandular structure can be detected. The matter secreted is sometimes retained in the cells, and sometimes appears on the outside as an excretion. It is worthy of remark, that the secretions which are poisonous, such as the juice of hemlock or of cherry

(1) This is explained in the ALPHABET OF SCIENTIFIC CHEMISTRY, p. 108.

(2) What is known on the subject will be given in the ALPHABET OF ORGANIC CHEMISTRY.

laurel, must be retained in separate vessels, for when introduced into the plant through the roots, they act as poisons, and kill the very plants in which they had been secreted, in the same way as the poison from the sting of a bee, or from the fang of a serpent, will kill those animals.

ORGANS OF SENSATION.

Dr. Darwin fancied plants to be endowed not only with feelings, but with sentiment and passion; and more recently Dutrochet has attempted to demonstrate the existence of nervous organs in plants, at least in the sensitive plant, so well known for the singularity of closing and dropping its leaves when they are touched, or deprived of light, even by the shadow of a passing cloud. At the base of the leaf-stalk of this plant is a sort of bulging collar, composed of a delicate tissue of cells, upon which the motion of the leaf depends; for when the under part is cut away, the leaf remains bent down, and cannot again erect itself; and when the upper part, it cannot bend down; so that the collar obviously consists of two antagonist springs, set in motion, not by what he terms nervous globules—a sort of grains of a green colour diffused through the textures of plants—but, strange to say, by the vessels forming the pith tube.

That the irritability, as it is termed, of the sensitive plant, depends upon the carbon which it contains, or upon its due proportion of pulp, appears from its losing this irritability in the dark. Professor Burnet, from this cause, succeeded in retarding the restoration of a leaf which he had caused to droop, by blacking the springs of the foot-stalk, so as to interrupt the influence of light.

M. Dutrochet found by experiment on the leaves of the kidney bean, with the air pump, that they folded and nodded in proportion to the quantity of air in their air cells, independent of light and heat, whose influence it would thus appear is only exerted through the medium of the air.

It is certain that the leaves and young shoots of plants turn to the light[1]; that a leaf, when forcibly placed with its underside uppermost, twists round to regain its position; and that twining plants will only twine in one direction; from right to left, or left to right, according to the species.

M. Marcet, of Geneva, in experimenting upon the poisoning of plants, found that metallic poisons, such as arsenic, corrode and destroy them as they do animals, while vegetable poisons destroy irritability, also as in animals. M. Macaire of Geneva confirmed and extended these researches, and found that what is termed the sleep of plants, is thereby destroyed. Drs. Christison and Turner found similar effects produced by poisonous gases, some acting as irritants and some as narcotics. The irritant gases destroy first the parts least plentifully supplied with moisture; the narcotic gases destroy vegetable life by attacking it throughout the whole plant at once.

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(1) See fuller illustrations in the ALPHABET OF SCIENTIFIC GARDENING, pp. 17 & 28.

ORGANS OF REPRODUCTION.

It was first hinted by Grew, from information given him by Millington, and established afterwards by John Ray in England, and by Camerarius and Robart on the continent, that plants have reproductive organs, by which similar changes are effected in their seeds, as are produced in the eggs of insects and birds, by the pairing of males and females. It was upon this principle that Linnæus founded his celebrated system.

I have already briefly noticed these organs, as making part of the flower, under the head of members: the males being termed the stamens, each consisting of a filament and an anther; the female being termed the pistil, consisting of a style and summit above, with a seed-organ at its base. The use of the flower-scales, the flower-cup, and the blossom have not been ascertained.

The Anthers and Pollen.

The essential part of a stamen is the anther, usually formed of two small lobes or sacs, with a partition [1], having of course two chambers or cells [2], but sometimes one, sometimes four, rarely more, each anther being often detached and free; in other cases all the anthers of a flower may cohere by their margins, as in the thistle and the daisy. In the laurel, each of the

(1) In Latin, *Connectivum*. (2) In Latin, *Loculamenta*.

two cells of the anther has two small lids or valves, which open into the interior.

The cells of the anthers are filled with a peculiar matter termed pollen, which to the naked eye appears like a sort of dust or flour, most frequently yellow, but sometimes white, violet, or brown; and, when viewed by the microscope, having various forms in various species.

M. Guillemin describes the grains of pollen as minute bladders, containing granules [1] of extreme minuteness. The bladders may either be smooth and dry, as in the pea, the potato, gentian, spurge, pinks, and grasses; or covered with small knobs, giving out a clammy fluid, as in mallow, gourd, sun-flower, chicory, and bindweed. When dry grains are exposed to water, they change from spherical to elliptical; the viscid grains burst, and scatter a liquid denser than water, having myriads of granules swimming about in it with circulatory motion. Amici has seen these in motion for four hours.

M. Adolphe Brongniart, on examining an anther in a flower-bud long before blowing, found it in form of a tissue of cells, each cell in the progress of growth becoming separated from the others, and forming one grain of pollen, but sometimes these are enclosed in other larger cells which progressively burst. Each grain has an outer envelope, thickish, furnished with pores, and sometimes with elevated points; and an inner, very thin, transparent, and unconnected with

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(1) In Latin, *Fovilla.*

the outer. When exposed to water, the inner swells and bursts through the outer, forming a longish tube; or bursts at two opposite points, as Amici observed in the tree primrose.

In the orchis and swallow-wort[1] groups of plants, the pollen, instead of being in grains, is found in a solid mass, or several smaller masses united by an elastic net-work. It is in all plants very inflammable; and the peculiar odour of many flowers arises more from it than from the petals.

Needham formerly, and R. Brown lately, were led, from observing the spontaneous motions of pollen in water, to observe similar motions in inorganic substances, leading to the fanciful inference that all things are full of life[2].

The Pistils and Seed-Organs.

The pollen, when it arrives at maturity and bursts from the cells of the anther, is shed upon the summit of the pistil; either from the stamens being near it, or by the winds or insects, when they are at some distance on the same plants, as in the hazel, or on different plants, as in the hop.

M. Lecoq, however, appears to have proved by experiment, that fertile seeds may be produced in the female hop plant without the intervention of the male; and we have a similar example among animals in aphides, of which the hop-fly is a species.

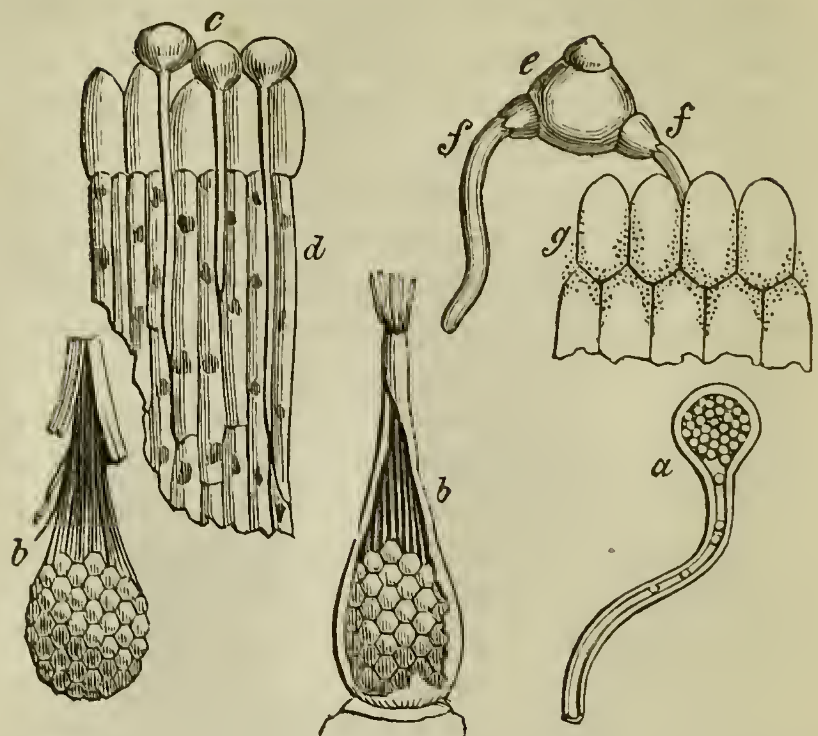
(1) In Latin, *Asclepias.*

(2) See the ALPHABET OF NATURAL PHILOSOPHY, OR PHYSICS.

The summit is well contrived for retaining the pollen that may fall upon it, from being without any rind to cover it and in all cases moistened with a clammy fluid, which causes the grains of pollen to swell, burst, and discharge their minute granules. Some suppose that these are taken up by spongelets in the summit similar to those of the root, while others allege that the fluid matter in which the granules float is sucked up.

Professor Amici discovered in 1823, that the grains of pollen, when shed on the summit, do not burst as they do in water, but in a few hours shoot out one or more very delicate tubes, which penetrate the tissue of the summit, and extend themselves down through the interior of the style, as far as the seed organ, where they expand between and around the nascent seeds, serving, it is probable, to convey thither the granules which at least enter into the tubes.

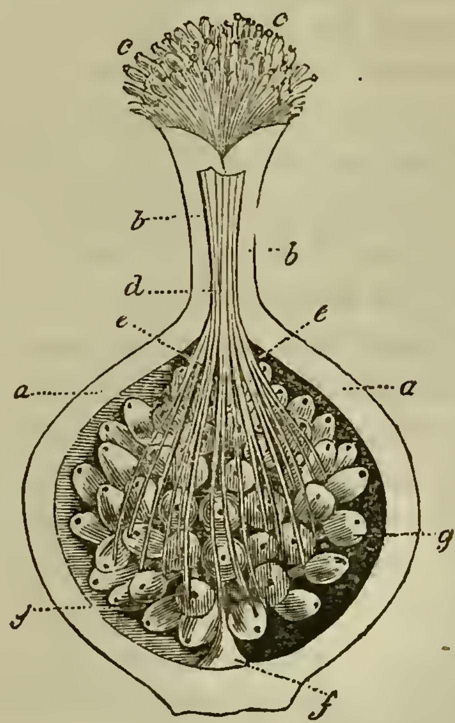
Mr. R. Brown is of opinion that the tubes, or the granules which they convey, only produce a stimulating effect on the nascent seeds, without penetrating their texture. In the swallow-worts the grains of pollen are inclosed in a kind of sac, the most prominent part of the convex edge of which is applied to the summit of the pistil as fecundation is about to take place, when a number of extremely slender threads, each being the pollen tube of a single grain, and not more than the 1500th of an inch in diameter, are emitted from this edge into the tissue of the pistil.



Proeess of the pollen penetrating into the pistil.—*a*, a grain of pollen from the swallow-wort with its tube and granules; *b*, *b*, seed-organs of the same plant with the pollen tubes penetrating to them; *c*, pollen of snapdragon with its tubes penetrating into *d*, the pistil; *e*, triangular grain of pollen in the tree primrose; *f*, *f*, its tubes; *g*, the tissue of the pistil.

M. Adolphe Brongniart, on the other hand, says there are no vessels for such conveyance, but the granules pass into the spaces between the cells in the summit; and he observed them penetrate deeper and deeper till they reached the seed-organ, where they actually find their way into the interior of the nascent seeds by means of a delicate membranous tube, at the end of which is a minute vesicle in which the embryo plant is formed, the neck of the vesicle forming the radicle.

M. Balliard is said to have traced coloured liquids, sucked up by the spongelets of the summit along the vessels of the style, till they arrived at the seed organ; and in the same way, it is inferred, the granules or their fluids are conveyed thither for the purposes of fecundation.



Fecundation in the Sunflower of the Nile:—*a, a,* walls of the seed organ; *b, b,* walls of the pistil; *c, c,* summit covered with grains of pollen: *d,* conducting tissue of the centre of the pistil; *e, e,* filaments from this tissue running to the nascent seeds; *f,* base of one of the walls of the verge: *g, g,* numerous nascent seeds placed perpendicularly on the verge.

The seed-organ is always placed at the base of the pistil, containing the seeds either nascent[1], or advanced to maturity[2], and bearing so strong a resemblance, both in structure and functions, to the egg organ of birds and insects, that the membranes and

(1) In Latin, *Ovula.*
(2) In Latin, *Semina,* or by modern writers, *Ova.*

other parts have received from naturalists the same scientific names.

The seed-organ[1] is usually of an egg-oblong form, and according as it may or may not unite by adhesion with the sides of the flower-cup, it is in some species placed above, and in others below the other parts of the flowers; consisting, in some instances, of one cell, in others of two or more cells, in which the seeds, one or many in number, are contained. The modern theoretical views of this structure are given below under Theory of Metamorphosis.

Gaertner describes the seed-organs before fecundation as composed simply of small cells, which ultimately become the chambers in which the minute globules originate that are to form the seeds.

Mr. R. Brown observed in fragrant coltsfoot, and other plants, two thread-like cords running from the base of the seed to the base of the style, for the purpose, as he conceived, of conveying nourishment; and there is a similar connection between the stem bulbs and the stem in the tiger lily.

Linnæus describes certain seeds as naked; but the envelope[2] of the seed-organ is, with very few exceptions, such as in firs and pines, and the sago plant, never wanting, though sometimes it is so thin as not to be easily seen. It is always composed of an outer membrane[3], a middle membrane[4], and an inner membrane[5]

(1) In Latin, *Ovarium.*

(2) In Latin, *Pericarpium.* (3) In Latin, *Epicarpium.*

(4) In Latin, *Mesocarpium* or *Sarcarpium.*

(5) In Latin, *Endocarpium.*

all intimately united. These parts are very distinct in the peach, but not obviously distinct in the nut.

The outer membrane is formed of the tube of the flower-cup, when the seed organ is below this, and then the pulpy part of the flower becomes the middle membrane.

The middle membrane forms the fleshy or pulpy part of peaches, apples, melons, and similar fruits, but in the case of thin and dry envelopes it may be known by its always containing vessels, or traces of such as have been dried up by evaporation in the process of ripening. The outer coat of the stone, in stone fruit, belongs to this middle membrane.

The inner membrane is that which immediately encloses the seeds, and usually contains one chamber, as in the cherry and filbert; or several, as in the apple and pea: in the first case, thick, hard and stony; in the second, thin and husky. This membrane has three parts which require notice, the partitions and the verge with its expansion, in flowers having more than one petal.

The partitions[1] are usually formed by the two layers of the inner membrane, and alternate with the summits of the pistils, or their divisions, in the form of vertical plates; but sometimes they are not formed by two layers, and do not alternate, when they are absurdly called *false* or *spurious* partitions by botanists, as in the poppy and the thorn apple.

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(1) In Latin, *Septa*, or *Dissepimenta*.

As every seed derives its nourishment from the inner membrane, there must be a communicating point, and this point being always on the verge[1] of the membrane, may be so termed; that on the seed being termed the seed-scar[2], but popularly, though improperly named the *eye*. In some species, the verge bears a number of smaller verges, to each of which a seed is attached, by what is named the *navel string*[3], by those who pursue animal analogies to extreme minuteness, but is better termed the verge-cord or seed-stalk[4]; all these parts are obvious in an unripe pea or bean.

The verge of the seed-stalk sometimes occurs in the form of an expansion[5], surrounding the seed in a greater or less degree, which has been mistaken for a part of the seed. It is this expansion in the nutmeg which forms the mace of commerce.

The centre of the seed-organ is sometimes formed of a sort of support, round which the seeds are ranged, termed the pillar[6], and theoretically represented as consisting of several verges united in a whorl[7], with a space between.

The peculiar manner in which seed-organs open when ripe, is also distinguished by the term dehiscence[8], when it does not open, by indehiscence. The

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(1) In Latin, *Limes seminiferus*, *Trophospermium*, or *Placenta*.
(2) In Latin, *Hilum* or *Umbilicus*.
(3) In Latin, *Funiculus umbilicalis*.
(4) In Latin, *Podospermium*. (5) In Latin, *Arillus*.
(6) In Latin, *Columella*. (7) In Latin, *Commissura*.
(8) In Latin, *Dehiscentia*.

opening may take place so that while the cells continue closed at the back, the partitions divide lengthwise into two plates [1], as in Irish heath, and laurel rose; it may take place so that the cells open at the back, while the partitions continue undivided [2], as in the lily and the lilac; it may take place by the separation of the partitions from the valves [3], as in bindweed; it may take place along the inner edge of a simple fruit [4], as in the pea; it may take place cross ways [5], as in pimpernel and plantain; it may take place by teeth, as in pinks; by pores or holes, as in poppy, toad flat, and bell flower; or by cross contractions, as in bird's foot.

The seed vessel of a lychnis, opening at the top, by its valves, for the dispersion of seeds.

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(1) In Latin, *Dehiscentia septicidalis.*
(2) In Latin, *Dehiscentia loculicidalis.*
(3) In Latin, *Dehiscentia septifragalis.*
(4) In Latin, *Dehiscentia suturalis.*
(5) In Latin, *Dehiscentia circumscissilis.*

The Seed.

The structure of seeds is no less curious than that of the seed-organs. The regions of a seed are named from the position of the seed-scar which is placed at the base [1]; the point opposite, the tip [2]; the upper part, the back [3]; the opposite to that, the belly [4]; and between the two, sides [5]. In curved seeds, such as in mignonette, the base and the tip become opposite.

M. Turpin describes the seed-scar, which he observed in 1200 seeds, as consisting of a seed pore, and this again often, if not always, exhibiting a larger seed pore [6], for the passage of nutrient vessels, and a smaller seed pore [7] for the passage of fecundating vessels. M. Mirbel describes an outer seed pore [8], and an inner seed pore [9]. The seed scar is sometimes large, as in the horse chestnut, and sometimes small, as in the poppy. It is through the seed pore that the young plant appears in germination.

The outer coat of the seed may be properly termed the shell [10], and consists in most cases of a simple and single membrane; but sometimes this is thickish, fleshy internally, and separable, according to Gaertner, into two coats,—an outer [11], and an inner [12], as in the castor

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(1) In Latin, *Basis*.
(2) In Latin, *Vertex*.
(3) In Latin, *Dorsum*.
(4) In Latin, *Venter*.
(5) In Latin, *Latera*.
(6) In Latin, *Omphaloidum*.
(7) In Latin, *Mycropylum*.
(8) In Latin, *Exostoma*.
(9) In Latin, *Endostoma*.
(10) In Latin, *Endospermium*.
(11) In Latin, *Testa*.
(12) In Latin, *Membrana interna*.

oil plant; but M. A. Richard denies the existence of two different membranes. Malpighi and Grew however mention an outer coat, still different and more delicate[1]; and Grew one still within Gaertner's inner coat, immediately investing the seed.

The shell of the seed, like that of eggs, is so composed as to protect them from extremes of heat and cold; but that of seeds will remain uncorrupted for many years, so that wheat, found with mummies probably 3000 years old, has been made to germinate.

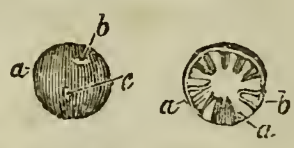
What becomes the shell of the seed consists, in the unripe seed, of two envelopes, one including the other, and these including, according to M. Mirbel, three others, but all five united in some part of their texture. The outer is termed primine; the next secundine; the three inner collectively, the kernel; and severally, tercine, quartine, and quintine; the last being the centre of the kernel. When in the progress of ripening the base of the kernel rises partially, or altogether, to the tip of the seed, it remains connected with that base by certain vessels termed the vascular cord[2], and when this cord expands at the base of the kernel it is termed the ball[3].

The shell, viewing it in ripe seeds, envelopes the more essential part termed the kernel[4], which in some instances is composed of one body only, termed the embryo; and in others, besides this, what may be

(1) In Latin, *Pelicula.* (2) In Latin, *Raphe.*
(3) In Latin, *Chalaza.* (4) In Latin, *Nucleus.*

termed the outer seed-pulp [1], or white; and in others still, a body which may be termed the inner seed-pulp [2], or yolk. These seed-pulps, which are green in misseltoe, white and mealy in wheat and oats, and oily in spurge, are not connected with the embryo by vessels, but serve to nourish it, as has been proved by the experiments of Dr. Yule, and M. Mirbel. In the greater number of seeds, however, the seed-pulp, instead of being separate and distinct from the embryo, is contained within its substance.

Fig. 1. Fig. 2.



Seeds of the cabbage palm.—Fig 1. *a*, the seed with its shell; *b*, the seed scar, with the seed pore; *c*, the vascular cord which runs from the scar half way down to the pore. Fig. 2. The seed, cut across to show the outer seed pulp in form of teat-like rays from the shell, *a*, to the centre; *b*, the embryo, bluntly tapering and placed on one side.

The embryo of a seed consists of four parts: the radicle, the seed-lobe or lobes, the neck, and the gemlet; all of which are important to be noticed in the progress of germination, and with regard to the foundation of modern systems.

The radicle [3] forms that extremity of the embryo from which the root springs in the progress of germina-

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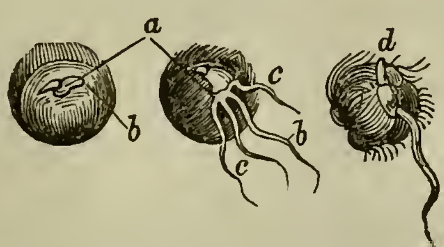
(1) In Latin, *Albumen*. (2) In Latin, *Vitellus*.
(3) In Latin, *Radicula*.

tion ; and before this it is always simple and undivided, but afterwards it may divide into branching radicles, as in grasses and misseltoe. The radicle may be naked without any external envelope, becoming, as it enlarges in growth, the root of the plant, as in borage, dead nettle, cabbage, and kidney bean [1]; it may be enveloped and concealed in a sheath [2] which bursts during germination, and gives passage to the tubercles of the radicles [3], as an Indian shot; or it may be incorporated with the seed-pulp [4], as in the pines as firs. Upon these three distinctions Richard founded a system.

Fig. 1. Fig. 2. Fig. 3.



Germinating seeds of cabbage palm to show—*a*, the radicle as it bursts through the seed pore, with the sheath ; *b*, the root fibre ; *c* and *d*, the gemlet.

The seed-lobe [5] is very various in form and in size, being sometimes considerable, and sometimes so small as to elude the naked eye; and though the colour

(1) In Latin, *Plantæ exorhizæ*. (2) In Latin *Coleorhiza*.
(3) In Latin, *Plantæ endorhizæ*. (4) In Latin, *Plantæ synorhizæ*.
(5) In Latin, *Cotyledon*.

may be white, yellowish, or purple, it is always green after germination. It may be simple and without any division, as in corn, grass, lilies, and other bulbs [1]; or it may be formed of two lobes united base to base, as in the beam and castor oil plant [2]; upon this principle Jussieu founded his system. But it is inconsistent with this system, that the lobes may be three, as in drooping cypress ; five, as in larch ; six, as in deciduous cypress; and even ten or twelve, as in the pine fir. Sometimes it is difficult to ascertain whether the lobes be one or more. In some cases, during germination the seed-lobes remain below ground [3], as in the horse chestnut; in others they appear above ground [4] in the form of seed leaves [5].

Seed lobes in a bean, with the nutrient vessels branching through them. *a*, *a*, root; *b*, *b*, gemlet.

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(1) In Latin, *Plantæ Monocotyledones.*
(2) In Latin, *Plantæ Dicotyledones.*
(3) In Latin, *Cotyledones hypogei.*
(4) In Latin, *Cotyledones epigei.*
(5) In Latin, *Folia seminalia.*

The neck[1] is not always distinctly marked as a part separate from the radicle; but when it is remarkable, it forms the crown of the radicle and the base of the seed-lobe, and it is by the lengthening of the neck that the seed-lobes are raised above the ground, as in the cabbage, radish, and mustard. Dr. Yule considers it analogous in wheat to the base of the bulb in lilies and other bulbs.

To consider the neck with Lamarck as the life-knot, and with Treviranus to call it the centre of vegetation, is as fanciful as the notion of Mr. Main, that vegetable life is a distinct member of a plant situated between the pulp bark and the pulp wood. Life, as De Candolle justly remarks, is diffused through every part of a plant, and the neck is only the point of junction of the root and the stem.

The gemlet[2], or, as it it has been termed, the plume or plumelet, is a small body, often formed like a feather, situated in the cavity between the seed-lobes, when there is but one; and between the lobes when there are two. It is the first bud, in fact, from which all the parts of the plants above ground are progressively evolved. It is often so small as to escape observation. It is in all cases nourished by the seed-pulp, contained in the seed-lobes or beside them, and these are prevented from adhering to it by a very fine pellicle. Like the radicle, the gemlet is also at first inclosed in a sheath[3].

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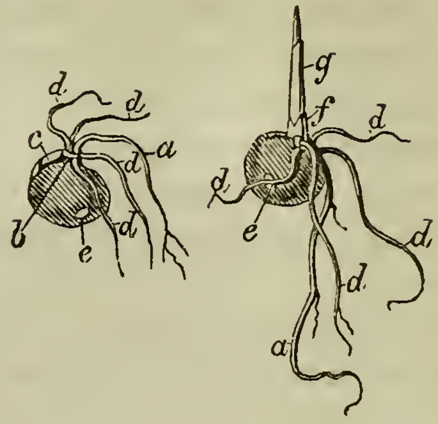
(1) In Latin, *Collum* or *Cauliculus*, or, as Treviranus terms it *Centrum Vegetationis*.

(2) In Latin, *Gemmula*, or *Plumula*. (3) In Latin, *Coleoptilon*.



Germinating seeds of cabbage palm, to show the gemlet with its sheath. *a*, *a*, the first radicle; *b*, its sheath; *c*, the gemlet just appearing; *d*, *d*, *d*, *d*, *d*, *d*, *d*, *d*, branches from the first radicle; *e*, *e*, seed pore; *f*, sheath of the gemlet; *g*, the gemlet with a cleft tip, through which the inner leaf shoots.

The embryo of the seed may be erect [1], as in the apple and plum; inverted [2], as in the nettle and rock rose; oblique [3], as in the primrose; or curved [4], as in the pink and pea.

Arrangement of Seeds and Fruits.

The number of sorts of seeds and fruits which various plants produce, require to be disposed in some order, a subject which has been carefully studied by Gaertner, Richard, Mirbel, and Desvaux. The best arrangements are still very defective.

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(1) In Latin, *Orthotropus* or *Anatropus*.
(2) In Latin, *Antitropus*. (3) In Latin, *Heterotropus*.
(4) In Latin, *Campulitropus*.

Seeds may be either close[1], or dehiscent[2]. A close seed may be a grain[3], like wheat, maize, and rye-grass; it may be a simple pip[4], as in thistle and sun-flower; it may be a composite pip[5], as in borage, dead nettle, lady's bed straw, ranunculus, parsley, and hemlock; it may be a key[6], as in ash, maple, and elm; it may be a gland[7], as in the oak and filbert; or it may be a utricle[8], as in the lime, the nettle, and orach.

A dehiscent seed may be follicle[9], as in the laurel rose; it may be a double follicle, as in swallow wort; it may be a purse[10], as in the cabbage and wall flower, it may be a purselet[11], as in honesty and shepherd's purse; it may be a pod[12], as in the pea, the bean, bladder senna, cassia, and astragalus; it may be a capsule[13], as in the pimpernel, poppy, and pink; it may be a caper[14], as in spurge; or it may be a cone[15], as in alder, birch, and fir.

Fruits, as popularly distinguished from seed, are more succulent or fleshy, and are all close. Botanists consider fruits to be the ripened seed organ. A fruit

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(1) In Latin, *Indehiscens*. (2) In Latin, *Dehiscens*.
(3) In Latin, *Cerium*, or *Caryopsis*.
(4) In Latin, *Achenium*. (5) In Latin, *Polachenium*.
(6) In Latin, *Samara*. (7) In Latin, *Glans*.
(8) In Latin, *Utriculum*, or *Carcerulus*.
(9) In Latin, *Folliculum*. (10) In Latin, *Siliqua*.
(11) In Latin, *Silicula*. (12) In Latin, *Legumen*.
(13) In Latin, *Capsula*, and *Pyxidium*.
(14) In Latin, *Elaterium*.
(15) In Latin, *Conus*, or *Strobilus*.

may be a stone fruit[1], as the plum, the cherry, and the haw; it may be a nut[2], as the walnut and the almond; it may be a nutlet[3], as in the ivy; it may be a pome[4], as the apple, pear, and hip; it may be a pepon[5], as the melon and cucumber; and it may be a berry[6], as the vine, potato, gooseberry, orange, and fig; but the strawberry and raspberry rank as seeds with composite pips; and the mulberry and pine apple as a compound berry[7].

(1) In Latin, *Drupa*. (2) In Latin, *Nux*.
(3) In Latin, *Nuculanium*.
(4) In Latin, *Pomum*, or *Melonida*.
(5) In Latin, *Peponida*. (6) In Latin, *Bacca*.
(7) In Latin, *Sorosis*.

GROWTH OF PLANTS.

The reader who has paid any attention to the preceding details, will be prepared to follow the progress displayed by the seed, from the time it leaves the parent plant till it becomes a plant every way similar; and may thus become acquainted with the whole history of vegetation from the commencement of germination till the decay and extinction of organic life. As it is requisite for a seed to be placed in an appropriate soil and situation before it can germinate, I shall first notice the various ways in which seeds are diffused.

RIPENING AND DIFFUSION OF SEEDS.

When fecundation has taken place, the nascent seed becomes a peculiar centre of life, and attracts towards it a supply of pulp, and the seed vessel becomes enlarged, acting, so long as it continues green, precisely like a leaf. The nascent seeds which have not been fecundated shrivel up and die; and it is remarkable that in the oak and the horse chestnut, though there are six nascent seeds, only one of these is evolved and ripens. In some species, as the cultivated pine apple and the bread-fruit tree, though the nascent seeds are not fecundated, the seed-organ becomes abundantly evolved, and thereby much improved for the table.

The greater number of plants ripen their seeds within a year after fecundation; but firs and pine trees require more, and the cedar takes no less than twenty-seven months to mature its cones.

As soon as the fruit becomes perfectly ripe, the different parts of the seed-organ separate in various manners, and the seeds are loosened and scattered by the means which Providence has contrived for continuing and disseminating the species, as well as by the enormous number of seeds produced. Ray counted no less than 32,000 seeds on one poppy plant, and 360,000 on a plant of tobacco; but were all these to be disseminated and grow, a single species would soon overrun the whole surface of the globe; a circumstance prevented by the over produce being eaten by various animals, for whose subsistence, indeed, it seems to have been expressly provided. Animals, indeed, and man himself, are active agents in the diffusion of seeds; the missel thrush disseminating the misseltoe berries, and the European weeds having become common in America by being carried thither (not intentionally) by European settlers. Rivers and seas also diffuse seeds by conveying them to distant regions; and thus islands which rise from the sea by volcanic or other agency, become in time covered with vegetation.

The seed-organ itself often opens with a spring-like mechanism, calculated to project the ripe seeds to a distance, as in the balsam, the sand box tree, the wood sorrel, and in the violets. In the latter, as I have observed, the seeds are contained in an organ of three valves, the sides of each of which shrinking and collapsing with the sun's heat, press with their hard edges upon the slope of the smoothly polished seed, and along this the edge slides forcibly down, and the seed is consequently torn from its fastening, and thrown with a jerk to a considerable distance. It is worthy of remark, also, that before the seed is ripe, the whole head hangs drooping, with the persistent flower cup spread over it, like an umbrella, to guard it from rain and dews that would retard its ripening; but as soon as it is ripe it rises to an upright position, with the cup for a support, while it gains in this way a greater elevation for scattering the seeds. In a drawer, I found the ripe heads of heart's-ease project their seeds about two feet; and when enclosed in a pill box, they may be heard successively popping against the lid as they are discharged.

The above is an instance of a seed-vessel bursting from becoming dry. De Candolle gives a still more singular one in the rose of Jericho from its meeting with moisture. "This little plant," he says, "grows in the most parched deserts. By the time it dies, owing to the great drought, its tissue has become almost woody, its branches fold over each other, till the whole assumes the form of a ball; its seed vessels have their valves tightly shut, and the plant remains adhering to the ground by a solitary branchless root. The wind, which always acts powerfully along the surface of a sandy plain, uproots the dry ball and rolls it along. If it now chance to meet with a plash of water whilst performing its constrained but necessary journey, it speedily imbibes the moisture, which causes the branches to unfold and the pericarps to burst; and the seeds, which could not have germinated if they had fallen on the dry ground, now sow themselves naturally in a moist soil, where they are able to grow, and where the young plant may support itself."

A number of seeds are so thin and light as to be easily carried about by the winds, such as cotton grass, virgin's bower, avens, dandelion, and thistle, which are furnished with wings studded with down [1] to fly withal; some other plants, such as the ash, the fir, and the sycamore, have seeds with membranous wings [2]; while others are furnished with hooks for adhering to animals, as the burdock. The most interesting, however, of these floating seeds, perhaps, are the minute bulbs (if bulbs they are) of mosses, such as grow on walls and trees, which being wafted about, as it would appear, in great numbers, and being so minute and light as to easily adhere, soon cover a newly-built wall with a thin green coating, mistaken by Linnæus for a peculiar plant which he termed silk moss [3]; but proved by Mr. J. Drummond, formerly of Cork, to be the germinations of several common mosses. The green matter of Dr. Priestley, produced on stagnant water, has the same origin from moss seeds.

GERMINATION.

The evolution of a young plant from a seed, which is termed germination [4], depends upon the seed itself

(1) In Latin, *Pappus*.
(2) In Latin, *Alæ*.
(3) In Latin, *Byssus*.
(4) In Latin, *Germinatio*.

having been duly fecundated by the pollen, then perfectly ripened, and afterwards not exposed to destructive degrees of cold or of heat, to freeze its juices in the one case, or parch them up in the other. Some seeds, as those of the coffee plant, require to be sown almost immediately on being gathered; others, if kept from air, light, and moisture, may be kept long good, such as those of the sensitive plant.

The external circumstances necessary to germination depend on water, heat, and air, and, as connected with these, on soil and situation; though soil is not indispensable, for seeds, such as those of mustard, will germinate on a sponge or a moist piece of flannel.

Water is indispensable, from its being the common vehicle in which the food of plants is taken up by the spongelets. In germination, water enters into the substance of the seed, swells the kernel, and causes the enveloping shell to burst, and, by carrying food into the seed-pulp and the seed-lobes, it supplies them with materials for increasing in bulk,—its decomposition and the new combinations of the elementary matters, producing starch, sugar, acids, oils, resins, woody fibre, and whatever else may be found in the germinating seed. Water, however, should not be too abundantly supplied, as in that case it will macerate the seeds, and cause them to rot; and hence a wet spring is unfavourable to corn, French beans, &c. and hence, also, the advantage of sowing in dry, rather than moist, weather.

Heat is no less indispensable than water; for the expansion of the parts is prevented by a temperature at or below the freezing point, and hence seeds will not germinate in such circumstances. When the temperature, again, is too high, that is, above 90° Fahr. the parts and fluids become too much expanded; and hence it has been found by experiment, that from 132° to 144° is unfavourable to germination.

Air is likewise indispensable to germination, though Homberg alleges that he made some seeds germinate in the exhausted receiver of an air-pump; an experiment, however, not since verified, and Saussure deemed it inaccurate. It is on this account that seeds long buried in the earth lie dormant, but when turned up, by digging or otherwise, soon germinate. Oxygen is the most indispensable requisite, for seeds placed in azote, or in carbonic acid gas, will not germinate. In pure oxygen gas, and as Humboldt found in a solution of chlorine, germination is very rapid, but the young plants thus produced soon perish.

Light, from its causing the disengagement of oxygen, and the retention of carbonic acid gas, is unfavourable to germination, because there is wanted the fixing of the oxygen, and the disengaging of carbonic acid gas. When the gemlet or plumule once gets to a certain size, however, it counteracts, according to Mirbel, the fermentation which light may have caused to begin, by converting the starch of the embryo into sugar and an emulsive fluid.

The time required for germination varies much in different species: thus, mustard takes little more than one day; cress, two days; spinach, turnip, and kidney beans, three days; lettuce, four days; most grasses, one week; hyssop, one month; parsley and celery, from six to nine weeks; the peach and almond, one year; and the rose, hazel, and cornel, two years.

Phenomena of Germination.

The first apparent change in a seed that has begun to germinate, is its obvious enlargement, and the softening of its shell, which ultimately bursts. Whenever the embryo begins to grow, it is termed the plantlet, and consists of two parts, one descending, and another ascending; the first being the embryo root, the second the embryo stem. As soon as the embryo stem or gemlet has reached the open air, its leafits are expanded, and begin to perform all the functions of leaves.

In the meanwhile the shell of the seed prevents the access of too much water, which might, as it were, drown the young plant, and hence Du Hamel found by experiment, that seeds when stript of their shell germinate badly, if at all. The seed-pulp, again, which is nothing more than what remains of the liquid in the cavity where the embryo was developed, being evaporated till it becomes a solid (though this, as in the milk of the cocoa nut, is not always quite effected), is again diluted with the absorbed water, and serves to supply nourishment. This is the case whether the seed-pulp be included or not in the seed-lobes, which it is only necessary to water sufficiently in order to see the whole grow, as was proved by the experiments of Desfontaines, Thouin, Labillardière, and Vastel.

Upright Growth of Plants.

It may be considered one of the most universal laws of germination, that every part of a plant, except the root, rises in an upright direction from the ground, in the same way as the root goes downwards. I have already mentioned the experiments of Mr. T. A. Knight, and Dutrochet, who placed germinating plants on wheels revolving both vertically and horizontally, when the stems uniformly tended to the centre of the wheel and the roots to the circumference, which tends to prove that gravitation is the chief agent in causing plants to rise perpendicularly. The same law will account for the side branches bending down, as in the weeping willow and the lime tree, while the main stem rises upwards. Lord Kames mentions an ash tree growing on the high wall of a ruin, which sent a root down along the wall to the ground; a circumstance easily accounted for on the same principle, though it has been adduced as a proof of instinct, if not of reason itself, in the tree.

What are termed creeping stems may be thought exceptions; but the runners[1], of the strawberry, and the suckers[2] of the sweet violet, are not by any means stems, but side shoots for the purpose of propagating new plants.

Weak stems, which are unable to rise high in a perpendicular direction, are furnished with various

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(1) In Latin, *Sarmenta.* (2) In Latin, *Stolones.*

means of attaining what at first may seem impossible. In some the stems merely rise amongst others in an irregular manner, as the bramble and the bitter sweet; while in others they twine closely around the stronger support, some from left to right with the sun, as the hop: and others from right to left, or against the sun, as the bind-weed and kidney-bean. It is singular, that when those plants are forced to wind in a contrary direction, it injures or kills them.

Germination of Plants with one Seed-lobe.

There being considerable differences in the two great classes of seeds having only one seed-lobe, and having two or more seed-lobes, I shall give some details of the progress of germination in each class; and for the first I shall select wheat, which has been most minutely described by Malpighi, Poiteau, and Yule.

The grain of wheat, after being moistened for about thirty hours, increases in size, and the sheath or envelope of the radicle, from being fine, smooth, opaque, and solid, becomes thick, downy, transparent, and cellular; and when the sheath bursts, there is seen a main radicle, and a smaller one at each side. At the same time, the gemlet may be observed, consisting of several rolled leafits resting on the seed-lobe. When the germination is a little farther advanced, a number of very minute rootlets are seen springing from the three radicles.

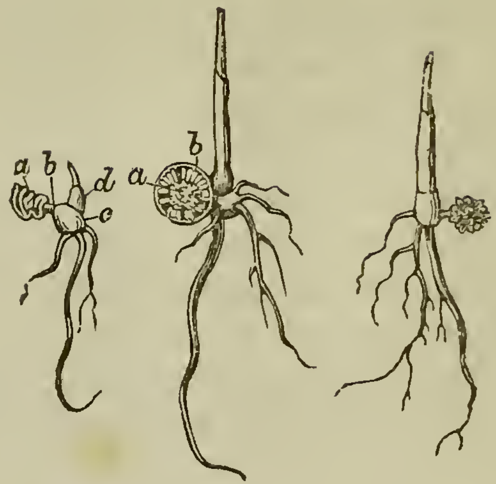
The first day, according to Malpighi, the body of the embryo is closely connected with the seed-lobe, which he terms a "farinaceous leaf." The second day the sheath gives way, the gemlet or plume rises upwards, and the seed-lobe appears moist. The third day the seed-lobe becomes quite turgid; the gemlet looks green; and two other radicles begin to sprout from the two side radicles, while their sheath begins to waste. Tbe fourth day, the seed-lobe when pressed yields a white sweetish fluid, somewhat like milk, while the other parts are increased in length. The fifth day the gemlet pierces the membranous envelope, pushing up a green rolled leaf sheathed by the envelope; the seed-pulp is much diminished; and the five radicles are nearly of a length, and clothed with hairs. About the sixth day, the plantlet, still in its sheath, begins to expand, while the envelopes of the seed shrink. After the eleventh day, these envelopes still adhere, but are much wasted, and yield on pressure only water and air, while the stem, now forming many knots, and the radicles, sending out many rootlets, progressively enlarge. After a month, new buds burst upwards from the crown of the root (formerly, as I think, the neck of the embryo), and new radicles shoot out downwards. After two months, several young plants are seen, enveloped in withered sheaths, rising from the same spot, the two original envelopes of the seed still remaining attached.

It is this mode of shooting up many stems that causes corn to be so prolific, Du Hamel having seen a seed of barley produce 200 ears, each having 24 grains, or in all 4800 grains. Other plants, with one seed-lobe, do not yield so many stems; but Poiteau says it is a general law of such plants for the main radicle to dry and fall off, and hence none of the palms have a tap root. When the top of the stem in wheat is destroyed, as it is by a small green-eyed fly[1], it threatens destruction to the crop, but side stems soon shoot, and no loss is sustained. In England it is the practice to eat down the young wheat with horses, to make it multiply the stems. Transplanting produces a similar effect.

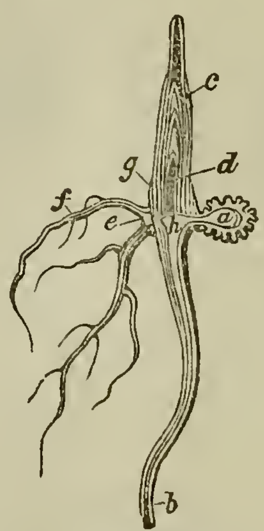
Dr. Von Martius has given a minute account, with interesting figures, of the germination of the cabbage palm, some of which I shall here give.

The Cabbage Palm (*Euterpe oleracea)* in three several stages of germination.—At *a*, the gemlet just escaped from the seed is slightly arched.

(1) In Latin, *Chlorops pumilionis.*



The same farther advanced.—*a*, the central part of the embryo twisted ; *b*, the neck ; *c*, the first radicle ; *d*, the sheath.



The same farther advanced.—*a*, the central part of the embryo ; *b*, salient point of the radicle with its pith ; *c*, *d*, the stem and leaf of the young plant ; *e*, the root sheath ; *f*, side rootlets; *g*, gemlet sheath ; *h*, neck or dividing line between the root and the stem.

Germination of Plants with two Seed-lobes.

In this class of plants, the parts, from being usually larger, are more easily observed than in those with one seed-lobe, the radicle projecting like a small cone, and the naked gemlet lying between the two lobes. I shall again follow Malpighi in tracing the progressive growth of the pea.

After being planted or moistened in a dark place for one day, the shell becomes softer, whiter, and thinner, and while the scar remains shut, an irregular opening occurs near it. On stripping off the shell, the two seed-lobes are seen distinct, having the small gemlet with yellow leaves, and the white radicle between them, while the neck is seen united to each seed-lobe by a minute stem. The second day the shell gives way, and the radicle protrudes. The third day it sends out many rootlets, while the seed-lobes separate and show the gemlet. By the fifth day the white stem mounts upward, with the curved green gemlet on the summit. By the end of the seventh day the whole is much advanced, there being distinct knots on the stem, the radicle much lengthened, and the seed-lobes, when pressed, giving out a bitter juice. By the ninth day the plant is completely formed, while the seed-lobes are shrinking, and at the end of a month they are thin and wrinkled.

It would be an interesting exercise for the young botanist to watch the progress of germination in this manner.

Germination of the Pea.—*a*, the pea stript of its skin and split open, to show the two cotyledons or seed-lobes, with the embryo plant between them; *b*, a profile view of the same parts; *c*, *d*, *e*, *f*, *g*, successive stages of the growth of the plant from the seed:—*c*, the seed-lobes bursting the outer skin; *d*, the root striking downwards; *e*, the plant about to unfold its seed-leaves, and the seed-skin torn and withering; *f*, the seed-leaves expanded, and the root becoming fibrous; *g*, the perfect plant.

In the chestnut and the horse chestnut the seed-lobes are very large and thick, but do not rise above ground, and send up only the gemlet, and this in time becomes the trunk or stem, which I shall now describe.

The Trunk of Plants.

The body of a tree or shrub is always thickest at the base, tapering as it rises, and composed internally of what is termed wood, covered by the bark, already described. The woody portion of a tree consists of the following distinct parts:—

Immediately within the inner bark we find first a soft pulpy layer, usually of a white colour, which I shall term the pulp-wood[1], sometimes inaccurately named sap-wood.

In succeeding years, besides this pulp-wood, we find one or more rings of wood[2], harder and closer in the grain, the innermost being the hardest. This innermost ring forms what is termed the pith-tube[3], which is of various forms, being usually cylindrical, sometimes elliptical or angular, but always, according to Du Petit Thouars, retaining the same dimensions at every stage of growth. This tube encloses the pith[4], which is a light spongy substance, dry in old trees, but moist in young trees, and in shoots and branches of the first year, as may be seen in elder or bower tree.

In herbs having two seed-lobes, the structure of the stem is somewhat different, the distinction between the two layers of bark, the pith-wood, the hard wood, and the pith, being seldom apparent, though in endive this is sufficiently distinct. In hemlock and cow-parsnep, the centre of the pith forms a hollow tube of considerable width.

In the stem of grasses, corn, and reeds, instead of pith, as in trees, the centre is hollow, and there are only two parts whose structure is different.

The stem of palms, though solid, more nearly resembles that of the grasses than that of trees, though

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(1) In Latin, *Alburnum;* in French, *Aubier.*
(2) In Latin, *Lignum.* (3) In Latin, *Tubus medullaris.*
(4) In Latin, *Medulla,* which is inaccurate.

in height many of the palms outrival forest trees. In the palms the hardest part of the wood is the outer, and the softest the inner.

GROWTH OF TREES HAVING TWO SEED LOBES.

PHILOSOPHICAL botanists have held very different opinions respecting the mode in which trees grow in thickness or diameter, as I shall now detail.

The difficulty, indeed, of arriving at facts, uncontaminated with theoretical fancies, in most of the points of vegetable physiology, is nowhere more strikingly exemplified than in the opinions advanced respecting the growth of plants, particularly trees, in diameter.

According to Malpighi, the interior part of the cortical tube, or in other words, the inner bark, produces the growth in thickness by successively uniting itself to the wood.

According to Grew there is formed every year, between the bark and the wood, a layer of vessels, which arises from the inner side of the bark and is converted into a new layer of wood. "Every year," he says, "the bark of a tree is divided into two parts, and distributed two contrary ways; the outer part falleth off, towards the skin, and at length becomes the skin itself: the inmost portion of the bark is annually distributed and added to the wood."

M. Parent says the interior portion of the bark is converted annually into wood.

Hales thinks that the pulp-wood (*alburnum*) or new layer of wood, arises from an extension of the fibres and tubes of the woody layer of the preceding year, as well as the new inner layer of the bark. Hales likewise says that he agrees in opinion with Borelli, who supposes the tender growing shoot to be distended like soft wax, by the expansion of the moisture of the spongy pith.

M. Mustel says, that emanations from the ligneous body form a new layer of wood, by means of the rising sap, and that emanations from the inner bark form, at the same time, a new layer of inner bark by means of the descending sap, by which latter term he must mean pulp.

Du Hamel, in order to satisfy himself respecting the truth of Grew's opinion, introduced a plate of metal between the bark and the wood of a tree early in spring, and when this was examined two or three years afterwards, it was found embedded in the wood, proving that the bark was not produced by the wood, though it was hence clear that the wood was formed on the outside of the metal plate. He came to the conclusion that the inner bark is every year changed into pulp-wood, and a new layer of inner bark formed to replace this. In the seed, before germination, he says, there is nothing but a dense tissue of cells, and no vessels can be traced: yet soon after the beginning of germination, a ring of vessels appears to form the commencement of the pith-tube, having the pith within it still green, and full of a watery fluid. Soon after, there appears outside the pith-tube, a layer of pulp which goes to form the first portion of the inner and outer bark, and as soon as there is another layer of pulp to replace this, the inner bark is converted into pulp-wood, and this every year is farther converted into hard wood. When a tree, accordingly, is cut across, these yearly layers may be observed, and the age of the tree may be thereby ascertained.

Mr. T. A. Knight says, the bark is never changed into pulp wood, nor into hard wood.

M. Mirbel appears to have somewhat altered his opinions at different times. He first says the inner bark is changed into wood and augments the mass of the ligneous body. Again, he says, the trunk is formed of one and the same cellular tissue, of which the rind forms the limit. But afterwards, in 1827, he expressly contradicts the first of these statements, saying, that the inner bark never becomes wood; but there is annually formed between the inner bark and the wood a new layer, which is a continuation of the wood and of the inner bark. This regenerating layer is termed pulp, which is not a fluid coming from one place or another, but a very young tissue that continues the older tissue. It is nourished and evolved by sap highly elaborated. Its organisation appears to be uniform throughout, yet the part which is in contact with the pulp-wood, changes insensibly into hard wood, and that which is in contact with the inner bark, changes in the same manner into the inner bark. The latter change is perceptible to the eye of the observer. In a young shoot, the pulp between the inner bark and the pulp wood gradually thickens, while fine fibres begin to appear therein, till at length it is crowded with vessels and cells, slowly and gradually formed.

M. A. Richard adopts similar views. He says, if a young branch be examined during the period of vegetation, that is, when the juices abound in all parts of the plant, there may be observed between the inner bark and the pulp wood a layer of fluid, at first clear and limpid, but gradually becoming thicker and less transparent. This fluid is composed of the descending pulp, and in proportion as it thickens, fibres are seen to form therein, and it soon becomes organised and acquires the appearance of vegetable tissue,—a change which is gradual, and continues so long as the buds are growing, so that the formation of the annual layer proceeds in a slow and progressive manner. It is on this account, that the new layers of pulp wood so frequently exhibit concentric zones, which shows that their whole thickness has not been formed at once. It hence appears, that the pulp wood is not formed by the inner bark thickening and becoming more consistent, but by the pulp which is organised, and thus becomes the means of growth in diameter, giving rise annually to the formation of a layer of pulp wood, and of a layer of inner bark, both distinct from each other, although produced by the same organ. When Du Hamel found in the pulp wood the silver wire, which he thought had passed through the inner bark, it was because it had been really engrossed in the organised layer of the pulp. It follows also, that the inner bark every year grows thick by its inner surface ; in fact, the layer of pulp spread over its inner surface becomes organised, and is added to this organ, so that it gradually acquires greater thickness,—the reason that the inner bark consists of several concentric plates, united together by a very fine layer of cellular tissue.

M. Kieser take a similar view, saying, that the sap rises in the wood, and after having undergone in the leaves a sort of respiration, it becomes pulp, in which form it descends by the bark and is deposited between the wood and the bark; hence the formation of a new layer of wood, and a new layer of bark.

Professor Link, of Berlin, and, more recently, M. Dutrochet, support the opinion that the stem grows in width as well as in thickness; trees, according to this view, being furnished with two systems, independent of each other, each having a centre or vital organic action, in opposite directions. The one system is central, comprehending the pith, the hard wood, and the pulp wood, the other is the tube of the bark, the interior of which is composed of the inner bark. Each of these systems acts on its own account, the result being a simple extension of tissue, namely, a layer of pulp wood upon the pulp wood, and a layer of inner bark upon the inner bark.

M. Dutrochet tried his first experiments upon a stem of traveller's joy, the end of a young branch of which, when cut across, he found to be composed of six bundles of fibres running lengthways, and separated by wide rayed spaces, in the centre of each of which spaces new bundles of fibres are annually produced, so that at the end of the second year, instead of six he found thirty bundles, separated by an equal number of spaces. This process ceases as soon as the wood is solid, but always continues in the bark, while the roots show it equally with the stem. By carefully studying, then, the manner in which the bundles of fibres are multiplied, it will be seen that the growth takes place in a lateral direction; a direct consequence indeed of new bundles of fibres forming in the centre of the rays, or that of rays in the centre of the bundles of fibres. The circular layers in this way increase in width.

With respect to growth in thickness, M. Dutrochet is of opinion, that each layer of new wood is first formed of a thin layer of pith, similar to that in the centre, full of cells, giving birth to vessels which form a pith-tube, so that each successive layer of wood is in reality a pith tube, the pith disappearing in all but the centre one. The bark, he thinks, grows in a similar way, by means of what he terms the bark pith, consisting of a thin layer of cellular tissue.

M. De la Hire, and afterwards Hales and Dr. Darwin, maintained an opinion respecting the growth of plants, which has lately been warmly taken up by M. Du Petit Thouars, and is adopted by Professor Lindley and by one or two living botanists. Professor Henslow says this "rests entirely upon vague conjecture and hypothetical reasoning; and it appears to me to be the most fanciful and baseless opinion ever propounded." According to this opinion, when a bud shows itself at the base of a leaf, or on a branch or stem, it follows two opposite movements, one upwards towards the air, the other downwards towards the earth. By the upward movement a new branch is produced, while the downward movement gives origin to a great number of new fibres which lengthen out between the bark and the wood of the mother branch, as well as of the trunk, down to the very extremities of the roots. These fibres descending from the bud, meet in their descent with the fibres from other contiguous buds, and these together form the annual ring of hard wood; the bark in the same way is increased by bark fibres descending from the buds. The whole of the bark and of the wood in this view are nothing more than the roots of buds.

It has been supposed that Hales had some opinion similar to this, when he says, "That it is not easy to conceive how additional ringlets of wood should be formed by a merely horizontal dilatation of the vessels; but rather by the shooting of the longitudinal fibres lengthways under the bark, as young fibrous shoots of roots do in the solid earth." However this may be, the opinion is clearly fanciful, as Professor Henslow has justly said.

Professor Amici says, I perfectly agree with M. Mirbel, that between the bark and the wood there are successively organised layers, of which one part unites with the pulp wood and acquires its nature, and the others are placed upon the inner bark, augmenting its mass. But we do not yet know the origin of the young tissue, which has been distinguished under the name of pulp tissue.

These several opinions may all be referred to three general heads.

I. That growth in diameter is carried on by the annual change of the inner bark into pulp wood, and of pulp wood into hard wood, and by the successive renewal of the inner bark.

II. That the successive formation of the layers of wood is produced by the evolving of buds.

III. That the annual formation of woody layers is owing to the pulp, which, every year, forms at one and the same time, a new layer of pulp wood, and a new layer of inner bark.

Our oaks and elms seldom exceed thirty feet in circumference; but the great chestnut tree on Mount Ætna is reported to be one hundred and sixty feet in circumference.

Growth in height, again, arises from the impulse given to the sap in spring, which rises first in the hard wood; and, as the season advances, in the sap-wood of the previous year. This expands the buds, and from the upper part of the stem young shoots rise, which, of course, possess one layer less than those of the preceding year; and by thus going down to the root in a tree ten years old, for example, we find ten rings at the base, while there are only nine above the second shoot, and only one at the summit.

Our forest trees seldom exceed one hundred feet in height, and are rarely so high as this, while palms often reach one hundred and fifty feet, without increasing an inch in thickness from the root to the summit. Von Martius describes one fifteen feet high, and not thicker than a man's thumb. The flower-stalk of the American aloe often reaches thirty feet, and M. A. Richard has seen this in another species[1]

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(1) In Latin, *Agave fœtida*.

grow as much as a foot in one day, and twenty-two feet and a half in eighty-seven days.

When the new layer of wood begins to harden, the rise of the sap is checked, and towards the end of autumn, little or no sap rises, while all the pulp and the watery vapour imbibed from the atmosphere descends. The vessels of the leaves consequently not being supplied with fresh pulp, are emptied and shrink, an effect sometimes hastened by the pressure of the newly-formed bud; and the leaves become detached and fall, except where the juices are very thick, as in holly, or resinous, as in fir, when the leaves do not fall till the new wood is formed. That the fall of the leaf is not caused by cold, is proved by the early fall of those of the ash or poplar; or by withering, appears from their adhering firmly to a branch cut off or killed in summer.

In India, where almost all trees, even our oaks, are evergreen, they produce an artificial fall of the leaf by uncovering the roots during the violent heats, for the purposes of subsequent forcing. When gardeners observe in their cuttings that the leaves wither and remain, they consider that the plant will not strike; but when the leaves fall, success is more certain, as this indicates that the swelling of the bud at the base has cut off the supply of sap.

AGE OF PLANTS.

Some plants, such as the minute funguses, termed moulds, only live a few hours, or at most a few days.

Mosses, for the most part, live only one season, as do the garden plants called annuals, which die of old age as soon as they ripen their seeds. Some, again, as the foxglove and the holyhock, live for two years, occasionally prolonged to three, if their flowering be prevented.

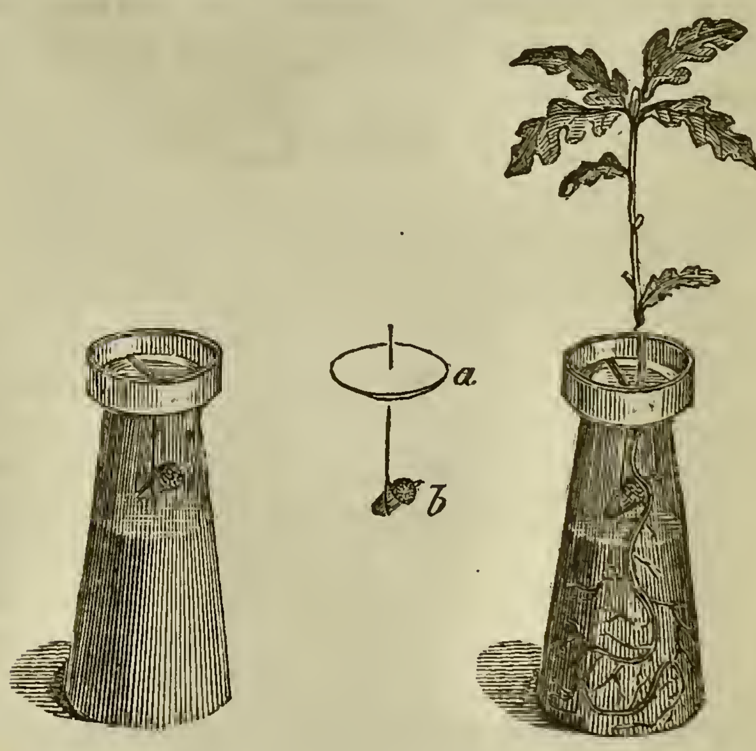
Trees, again, planted in a suitable soil and situation, live for centuries. Thus, the singular elephant plant has been said to attain, at the Cape of Good Hope, the age of two hundred years, reckoning by the rings in the bark of the crown; the olive may live three hundred years; the oak double that number; the chestnut is said to have lasted for nine hundred and fifty years; the dragon's blood tree of Teneriffe may be two thousand years old; and Adanson mentions banians six thousand years old.

De Candolle gives the following table of very old trees.

	Years.
Elm	335
Cypress	about 350
Cheirostemon	about 400
Ivy	450
Larch	576
Orange	630
Olive	700
Oriental plane	720 and upwards
Cedar of Lebanon	about 800
Oak	870, 1080, 1500
Lime	1076, 1147
Yew	1214, 1458, 2588, 2880
Taxodium	about 4000 to 6000
Baobab	5150 (in the year 1757)

When the wood of the interior ceases to afford room, by the closeness of its texture, for the passage of sap or pulp, or the formation of new vessels, it dies, and by all its moisture passing off into the younger wood, the fibres shrink, and are ultimately reduced to dust. The centre of the tree thus becomes dead, while the outer portion continues to live, and in this way trees may exist for many years before they perish.

An interesting mode of comparing the infancy of the oak with one of advanced age, is given by Ruricola, in the Field Naturalist's Magazine. He hangs to a piece of cork, *a*, an acorn, *b*, in a hyacinth glass, in which it will germinate and grow to some height.



THEORY OF THE METAMORPHOSIS OF PLANTS.

The term theory is very commonly used to bemask some wild fancy with the semblance of science; and I could not bring a stronger example of this than what has been termed the metamorphosis of plants [1], as must at a glance appear to every reader endowed with common sense.

The doctrine in question is alleged to have originated with Linnæus, in 1759-60, but the distinguished German poet, Goethe, thinks very lightly of the fancies which Linnæus termed anticipation [2], while he claims the honour of discovering (inventing, I should say) the doctrine of metamorphosis in 1790, a doctrine of which De Candolle is the most distinguished disciple.

The doctrine bears that every part of a plant consists of "disguised leaves," and hence the boles [3] of the stem, the flower-cup, the blossom, the stamens, and pistils, with the seed-vessels, and even fruit themselves, are nothing but leaves in a state of disguise or metamorphosis. "They are all the same," says Von Mar-

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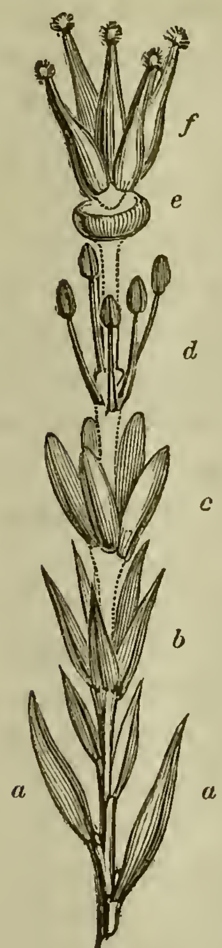
(1) Technically, *Morphology*. (2) Technically, *Prolepsis*.
(3) In Latin, *Internodia*.

tius, "in their essence, and only differ according to the intensity of their metamorphosis."

Von Martius farther instructs us, that every plant possesses two living forces, one vertical, the other spiral; by the action of which forces the plant is formed. By the action of the vertical force, the root goes down, and the stem rises up; and by the spiral force, the leaves, both in their natural state and in their disguised forms of flowers and fruit, are wound about the stem in spiral whirls. As soon then as a plant begins to grow, a series of leaves winds upwards around the stem in a spiral direction, and hence a whole plant is considered to consist of nothing more than a vertical axis, and a spiral of leaves.

The whole fancy well accords with, if it have not sprung out of, the speculative theory of what is termed *unity* by the German mystics, a phantom as unreal as the philosopher's stone. On their principle of unity they maintain that the same phenomena occur in every individual thing, and in every part of it, however different it may appear, otherwise the unity would not be maintained. Dr. Carus, for example, tells us that the liver and the kidneys, in animals, are mere *repetitions* of the lungs, and consequently are in reality lungs, in the same way as we have just seen flowers and fruit asserted to be *repetitions* of leaves. The spiral whirls again are said to depend on the general law of polarity, which consists of motion round an axis.

It will render the theory more obvious to exhibit the sketch of a plant conforming to its announcements:—



Theoretical plant of Professor Lindley, generated by a leaf whirling spirally; *a a*, the leaves as yet alternate; *b*, five leaves in a whirl degenerated into a flower-cup; *c*, five leaves degenerated into a blossom: *d*, five leaves degenerated into stamens; *e*, base of the footstalks of five leaves degenerated into a disc; *f*, five leaves degenerated into pistils.

In the more recondite parts of the theory, we are told that a stamen is really a leaf, the filament being the leaf-stalk, and the anther the leaf-plate, while the furrow between its two lobes is the mid-rib, and the pollen the leaf-pulp; that a disc is really the base of the foot-stalks of *abortive* leaves; and that the pistil with its summit is only a mid-rib denuded of its rind at the tip; while the seed organ is the expanded leaf-plate of the leaf folded with its upper surface inwards, round the axis, and having its edges united and adhering.

A leaf thus folded up into a seed-organ is termed a carpel[1], the adhering edges forming the verge[2], and buds upon these two edges forming two rows of nascent seeds. In some plants several leaves are said to be thus folded into a carpel, and hence the number of verges will correspond to those of the folded leaf-edges.

The cause assigned by De Candolle for this metamorphosis of leaves into flowers and fruit, is *degeneracy*, or, as Professor Lindley terms it, *stunting;* the parts of a flower being, therefore, *abortive* leaves. "A flower," says Mr. Lindley, "is in reality a *stunted* branch, that is, one, the growth of which is checked, and its power of elongation destroyed." "The fruit is in common language, the flower, or some part of it, arrived at its most complete state of existence; and, consequently, is itself a portion of a *stunted* branch."

It would be, I conceive, an unprofitable waste of time to expose the absurdity of these fancies, which have been generated by the erroneous logic of raising analogies into realities. The analogical resemblances are tolerably made out; but we would not surely conclude, that a butterfly is really a bird, or a bat, or a flying fish, because the wings are analogous, any more than we

(1) In Latin, *Carpellum*. (2) In Latin, *Placenta*.

can agree with the theorists in calling a rose or a peach a bundle of *abortive* leaves; produced, forsooth, as we have just seen it alleged, by *degeneracy* or *stunting*.

It seems indispensable for every theory to have a loophole through which to escape in case of difficulties; and in the present instance, the escape is made by maintaining Nature to be wrong when opposed to the theory. "All dissepiments," [partitions] says Professor Lindley, "whose position is at variance with the foregoing laws are *spurious*." It is needless to remark, that this mode of decision at once quashes all objection and puts an end to every appeal to fact. Well might M. Le Vaillant say, that "the present state of natural history often exhibits nature making sport of our systems." M. Le Vaillant elsewhere says that "one fact is enough to demolish a theory;" but here we have a theory demolishing the facts and calling them *spurious*.

SYSTEMATIC ARRANGEMENT OF PLANTS.

Since the time of Linnæus, it has been considered the only end and aim of botanists to class and name plants, which, as an amusement for passing time in a harmless manner, is unquestionably pretty and interesting, though by stopping here it seldom leads to any result more useful than this, and cannot as such be considered in the light of science and philosophy, whose object it always is to trace effects to their causes. When considered, however, as the mere rudiments of science,—as the first steps which a beginner must take,—as the horn book and spelling book, which it is necessary to master before it is possible to read the book of Nature, where the laws of causes and effects are to be studied; the classing and naming of plants is highly useful—nay, quite indispensable.

It follows most clearly, that to consider as genuine science an acquaintance, however extensive, with mere classification, whether that be termed artificial, like that of Linnæus, or natural, like that of Jussieu, is a gross and baneful delusion, though it is a delusion which has long prevailed, and at this moment continues to vitiate the observation, and waste the time, of some of the most ingenious men; while it misleads the beginner, at the commencement of his studies, into a by-path, from which he can seldom again find his way to the broad highway of true science. What is even worse than this, if worse can be, those who lay down the principles of such systems and classifications, deduce from them practical rules which are not only erroneous, but, if acted upon, may lead to serious mischief, as will be proved below, when I shall briefly consider a few of the excellencies and defects of the two systems of Linnæus and Jussieu, in their order.

LINNÆAN CLASSIFICATION OF PLANTS, CALLED THE ARTIFICIAL SYTEM.

THE system of the French botanist, Tournefort, who fixed on the petals of the blossom, as the means of distinguishing his twenty-two classes, though possessing several advantages, is far out-rivalled, in point of clearness, by that of Linnæus, who fixed upon the stamens, considering them in respect to their number, their insertion, their length, their union or their separation. The principle being so simple renders this by far the most distinct and easy method for a beginner to study. The division of the classes into orders, which is taken in a similar manner from the pistil, is equally clear and simple; the young botanist who finds a flower, having merely to count the stamens to find what class it belongs to, and to count the pistils to find the division of the class where it is placed. Now if all plants had been formed according to this principle, there would have been no difficulty at all in learning Linnæan botany; but this only holds in a considerable number, and fails in others; so that Linnæus, in order to include all plants, was obliged to resort to other considerations, in doing which he occasionally departed from his own principle, and, as his celebrated pupil, Fabricius, says, fell into error by adhering too closely to Nature. The sway which this system continues to hold, notwithstanding the efforts of its opponents to crush it, incontestibly proves Linnæus, as I have elsewhere remarked, to have been one of those rare master-spirits destined to fascinate and dazzle those of inferior mould, so far as to make them resign themselves unconditionally to his guidance. The characteristics of his genius, indeed, became apparent from his very boyhood, in his acquiring an extraordinary knowledge of plants in spite of every obstacle; his travelling from Upsal to Lapland amidst numerous privations, and the publication, at his return, of the Flora of the country, accurate and distinct even to a miracle. It is worthy of remark, that the venerable Boerhaave had penetration enough to foresee his celebrity long before he attained much distinction, forming his opinion, most probably, on his indefatigable perseverance, one of the most characteristic marks of genius. As the plainest mode of exhibiting the Linnæan classes, I shall give the following outline from Lamouroux as a

First Linnæan Lesson.

When a plant in flower is found, it must furnish an answer to one of the following questions:—

		CLASS
I. Has it stamens and pistils?	No.—Then it belongs to . .	24
	Yes.—Then see question II.	
II. Are the flowers with only stamens, or only pistils, and also with both stamens and pistils?	Yes.—Then it belongs to .	23
	No.—Flowers with only stamens on one plant, and flowers with only pistils on another, belong to . .	22
	Flowers severally with only stamens, or only pistils on different parts of the same plant, belong to . .	21
	Flowers with both stamens and pistils included in the same flower, see question III.	
III. Do the stamens adhere to the pistil?	Yes.—Then it belongs to .	20
	No.—Then see question IV.	
IV. Are the stamens united by the anthers?	Yes.—Then it belongs to .	19
	No.—Then see question V.	
V. Are the stamens united by the filaments?	Yes.—In more than two bundles it belongs to . .	18
	In only two bundles it belongs to	17
	In only one bundle it belongs to	16
	No.—Then see question VI.	
VI. Are there only six stamens, four being longer than the others?	Yes.—Then it belongs to .	15
	No.—Then see question VII.	
VII. Are there only four stamens, two being longer than the others?	Yes.—Then it belongs to .	14
	No.—Then see question VIII.	
VIII. Are the stamens more than twelve?	Yes.—Inserted upon the receptacle, it belongs to .	13
	Inserted upon the flower-cup, it belongs to . . .	12
IX. How many stamens are there under thirteen?	Twelve.—Then it belongs to .	11
	Ten.—Then it belongs to .	10
	Nine.—Then it belongs to .	9
	Eight.—Then it belongs to .	8
	Seven.—Then it belongs to .	7
	Six.—Then it belongs to .	6
	Five.—Then it belongs to .	5
	Four.—Then it belongs to .	4
	Three.—Then it belongs to .	3
	Two.—Then it belongs to .	2
	One.—Then it belongs to .	1

M

Second Linnæan Lesson.

After mastering the preceding lesson by Lamouroux, the beginner will be prepared to go a little more in detail into the system of Linnæus, as I shall now sketch it out.

Taking plants in general, with respect to their flowering, they are separated into two great divisions, —plants with apparent[1] flowers, which belong to the first twenty-three classes of Linnæus; and plants with non-apparent flowers[2], which belong to his twenty-fourth class.

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1. *Flowers with Stamens of a fixed number, and equal in length.*

FIRST CLASS *.

Flowers with only one stamen. If they have one pistil, as mare's tail, they are of the first order †; if two pistils, they are of the second order ‡.

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(1) In Latin, *Phænerogamia*, or *Plantæ phænogamicæ*.
(2) In Latin, *Plantæ cryptogamicæ*.
* In Latin, *Monandria*. † In Latin, *Monogynia*.
‡ In Latin, *Digynia*.

SECOND CLASS §.

Flowers with only two stamens. If they have one pistil, they are of the first order †, as sage, lilac, and speedwell; if they have two pistils, they are of the second order ‡ as sweet vernal grass; and if three, they are of the third order ||, as pepper.

THIRD CLASS [5].

Flowers with only three stamens. If they have one pistil, they are of the first order †, as crocus, iris, and cotton grass; if two pistils, they are of the second order ‡, as wheat, oats, and rye-grass; and if three pistils, they are of the third order ||, as blinks and jointed pipe wort.

FOURTH CLASS [6].

Flowers with only four stamens equal in length. If they have one pistil, they are of the first order †, as teasel, plantain, and woodroof; if they have two pistils, they are of the second order ‡, as dodder; and if they have three pistils, they are of the third order ||; and if four pistils, they are of the fourth order [7], as holly and pondweed.

§ In Latin, *Diandria*.
|| In Latin, *Trigynia*.
(5) In Latin, *Triandria*.
(6) In Latin, *Tetrandria*.
(7) In Latin, *Tetragynia*.

FIFTH CLASS [8].

Flowers with only five stamens. If they have one pistil, they belong to the first order †, as the primrose, violet, and currant; if two pistils, to the second order ‡, as carrot and hemlock; if three pistils, to the third order ||, as chickweed and alder; if four pistils, to the fourth order [7], as the grass of Parnassus; if five pistils, to the fifth order [9], as thrift and flax; and if many pistils, to the sixth order [10], as mouse-tail.

SIXTH CLASS [11].

Flowers with only six stamens of equal length. If they have only one pistil, they belong to the first order †, as the snow-drop and lily; if two pistils, to the second order ‡, as rice; if three pistils, to the third order ||, as dock and sorrel; if six pistils, to the fourth order [12]; and if many pistils, to the fifth order [10], as water plantain.

SEVENTH CLASS [13].

Flowers with only seven stamens. If they have only one pistil, they belong to the first order †, as the horse chestnut; if two pistils, to the second order ‡; if four pistils, to the third order [7]; and if seven pistils, to the fourth order [14].

(8) In Latin, *Pentandria*.
(9) In Latin, *Pentagynia*.
(10) In Latin, *Polygynia*.
(11) In Latin, *Hexandria*.
(12) In Latin, *Hexagynia*.
(13) In Latin, *Heptandria*.
(14) In Latin, *Heptagynia*.

EIGHTH CLASS [15].

Flowers with only eight stamens. If they have one pistil, they belong to the first order †, as the bilberry and the heath; if two pistils, to the second order ‡; if three pistils, to the third order ||, as bistort and persicaria; and if four pistils, to the fourth order [7], as herb Paris.

NINTH CLASS [16].

Flowers with only nine stamens. If they have one pistil, they belong to the first order †, as the laurel; if three pistils, to the second order ||, as rhubarb; and if six pistils, to the third order [12], as flowering rush.

TENTH CLASS [17].

Flowers with only ten stamens. If they have one pistil, they belong to the first order †, as rue and winter green; if two pistils, to the second order ‡, as the pinks; if three pistils, to the third order ||, as sandwort; if five pistils, to the fourth order, as stone crop and spurrey; and if ten pistils, to the fifth order [18].

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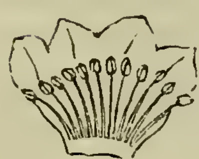
(15) In Latin, *Octandria*.
(16) In Latin, *Enneandria*.
(17) In Latin, *Decandria*.
(18) In Latin, *Decagynia*.

II.—*Flowers with Stamens of rather uncertain number, but of fixed insertion.*

ELEVENTH CLASS [19].



Flowers with from eleven to nineteen stamens, inserted into the receptacle. If they have one pistil, they belong to the first order †, as asarabacca; if two pistils, to the second order ‡, as agrimony; if three pistils, to the third order ||, as spurge and mignonette; if four pistils, to the fourth order [7]; if five pistils, to the fifth order [9]; and if about twelve pistils, to the sixth order [20], as houseleek.

TWELFTH CLASS [21].

Flowers with twenty or more stamens inserted into the flower-cup or the blossom. If they have one pistil, they belong to the first order †, as the plum and cherry trees; if two pistils, to the second order ‡; if three pistils, to the third order ||; if five pistils, to the fourth order [9], as in the apple-tree and meadow sweet; and if many pistils, to the fifth order [10], as bramble and strawberry.

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(19) In Latin, *Dodecandria.* (20) In Latin, *Dodecagynia.*
(21) In Latin, *Icosandria.*

THIRTEENTH CLASS [22].

Flowers with from twenty to one hundred stamens inserted into the receptacle. If they have one pistil, they belong to the first order †, as the poppy and lime-tree; if two pistils, to the second order ‡, as the peony; if three pistils, to the third order ||, as larkspur and monkshood; if four pistils, to the fourth order [7], as bugwort; if five pistils, to the fifth order [9], as columbine; if six pistils, to the sixth order [12], as water-soldier; and if many pistils, to the seventh order [1], as hellebore and anemone.

III.—*Flowers with two of the Stamens shorter.*

FOURTEENTH CLASS [23].

Flowers with four stamens, two longer and two shorter, inserted on a one-petalled blossom. If the four seeds are apparently not in a seed-vessel, but naked, they belong to the first order [24], as mint and thyme; if the seeds are not apparent, but concealed in a seed organ, they belong to the second order [25], as eye-bright and fox-glove.

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(22) In Latin, *Polyandria*. (23) In Latin, *Didynamia*.
(24) In Latin, *Gymnospermia*. (25) In Latin, *Angiospermia*.

FIFTEENTH CLASS [26].

Flowers with six stamens, four longer and two shorter, the blossom with more petals than one. If the seed-organ is a short pod, they belong to the first order [27], as shepherd's purse and honesty; and if a long round pod, to the second order [28], as turnip and mustard.

IV.—*Flowers with Stamens united by their Filaments.*

SIXTEENTH CLASS [29].

Flowers with the filaments of all the stamens united at the base into one bundle. If there are three stamens, they belong to the first order [5]; if five stamens, to the second order [8], as heron's bill; if seven stamens, to the third order [13], as stork's bill; if eight stamens, to the fourth order [15]; if ten stamens, to the fifth order [17], as geranium; if eleven stamens, to the sixth order [30]; if from twelve to twenty stamens, to the seventh order [19]; and if more than twenty stamens, to the eighth order [22], as the mallow and camellia.

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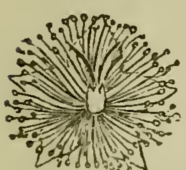
(26) In Latin, *Tetradynamia*. (27) In Latin, *Siliculosa*.
(28) In Latin, *Siliquosa*. (29) In Latin, *Monadelphia*.
(30) In Latin, *Endecandria*.

SEVENTEENTH CLASS[31].

Flowers with the filaments of all the stamens united into two bundles. If there are five stamens, they belong to the first order[8]; if six stamens, to the second order[11], as fumitory; if eight stamens, to the third order[15], as milk wort; if ten stamens, to the fourth order[17], as pea, broom, clover, and laburnum.

EIGHTEENTH CLASS[32].



Flowers with the filaments of all the stamens united into three or more bundles. If there are from twelve to twenty-five stamens unconnected with the flower-cup, they belong to the first order[19], as the orange tree; if the bundled stamens are inserted in the cup, to the second order[21]; and if there are more than twenty-five stamens unconnected with the flower-cup, to the third order[22], as in St. John's wort.

V.—*Flowers with Stamens united by their Anthers.*

NINETEENTH CLASS[13].

Flowers composite, with all the anthers in a floret united into a tube, while their filaments are not united. If all the florets are equal, they belong to the first order[34], as thistle and dan-

(31) In Latin, *Diadelphia*. (32) In Latin, *Polyadelphia*.
(33) In Latin, *Syngenesia*. (34) In Latin, *Polygamia æqualis*.

delion; if the florets of the circumference have pistils without stamens, to the second order[35], as daisy and groundsel; if the florets of the circumference have neither stamens nor pistils, to the third order[36], as the blue bottle and sunflower; if the florets of the circumference have pistils without stamens, and those of the centre stamens without pistils, to the fourth order[37], as marygold; and if the florets have a partial flower-cup all within a general flower-cup, to the fifth order[38], as globe thistle.

VI.—*Flowers with the Stamens and Pistils united.*

TWENTIETH CLASS[39].

Flowers with the stamens inserted upon the style or the seed-organ. If they have one stamen, they belong to the first order *, as orchis; if two stamens, to the second order§, as lady's slipper; if three stamens, to the third order[5]; if four stamens, to the fourth order[6]; if five stamens, to the fifth order[8]; if six stamens, to the sixth order[11], as birth wort; and if eight stamens, to the eighth order[15].

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(35) In Latin, *Polygamia superflua.*

(36) In Latin, *Polygamia frustranea.*

(37) In Latin, *Polygamia necessaria.*

(38) In Latin, *Polygamia segregata.*

(39) In Latin, *Gynandria.*

VII.—*Flowers of only one Sex.*

TWENTY-FIRST CLASS[40].

Flowers, some with pistils only, and some with stamens only, on the same plant. There are nine orders, taken from the number and bundling of the stamens as before.

TWENTY-SECOND CLASS[41].

Flowers with pistils only, or with stamens only, on two separate plants of the same species. There are nine orders, founded as in the preceding class.

TWENTY-THIRD CLASS[42].

Flowers with both stamens and pistils, and also with only one of these, both on the same and on separate plants of the same species. There are three orders.

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(40) In Latin, *Monœcia.* (41) In Latin, *Diœcia.*
(42) In Latin, *Polygamia.*

VIII.—*No Flowers apparent on the Plants.*

TWENTY-FOURTH CLASS [43].

Stamens and pistils if present, cannot, from their minuteness, be ascertained. The class contains five orders—ferns[44] mosses [45], liverworts [46], sea-weeds [47], and mushrooms [48].

Such is as plain an outline as I have been able to draw up of this celebrated system, which has proved so extensively injurious to philosophical inquiry and genuine science, by leading its disciples to mistake the means for the end. It may not be amiss to remark, however, that it appears easier to understand it on paper than to apply it in practice, for as nature will not bend to our imperfect systems, anomalies are constantly occurring which puzzle the beginner. For example, the flowers of red valerian have only one stamen, though they rank in the third class, because the other valerians rank there. In the twenty-fourth class again, the system fails altogether in guiding the student in his inquiries. But with all its defects, this system is every way superior in distinctness and easy

(43) In Latin, *Cryptogamia*.
(44) In Latin, *Filices*.
(45) In Latin, *Musci*.
(46) In Latin, *Hepaticæ*.
(47) In Latin, *Algæ*.
(48) In Latin, *Fungi*.

application to all others—and particularly to the system very improperly termed the Natural System, which I shall now notice.

CLASSIFICATION OF JUSSIEU, ALLEGED TO BE THE NATURAL SYSTEM.

It being obvious that the Linnæan system groups together plants which are comparatively incongruous, though they agree in the number of their stamens and pistils, it was thought desirable to fix upon some principle, which would allow of plants more alike in all respects, being associated in the same classes and orders. Viewing the seed then as a more important organ than the stamens and pistils, Jussieu devised a classification which takes its leading divisions from the seed-lobes; and it is this system, with its recent improvements or alterations, that is now in vogue among botanists in the highest repute, whose chief labours consist in its elaboration, by establishing new orders, and removing plants supposed to be wrongly classed, from one order to another; topics that lead to innumerable minute details respecting the seed-organ as well as the flower, and endless nibbling criticisms respecting the accuracy, or the errors, of preceding botanists upon these subjects. But with all due deference to the ingenious men who thus choose to spend their time, I am disposed to look upon such employment as precisely of the same character with that of the Linnæan botanist, who counts his stamens and pistils, or of the pin manufacturer, who sorts pins of particular sizes, colours, and polish, into their appropriate papers. Philosophy it cannot be, in any genuine acceptation of the term, and it is an insult upon common sense to make the assertion. In the system of Jussieu indeed, there is more exercise given to the mind, from there being more circumstances to observe and consider, than in the Linnæan system; and, in many instances, the plants grouped together are more congruous, or in keeping, as a painter would say, and therefore it is more in accordance with divisional logic; but to more praise than this the so-called *Natural System* does not appear to me to be entitled.

First Lesson on Jussieu's System.

The beginner, when it is required to class a plant in this system, must first procure the seed and examine the seed-lobes, and this must furnish an answer to one of the following questions:—

1. Has it any seed-lobes?	No.—Then it belongs to Division	I.
	Yes.—Then see question 2.	
2. How many seed-lobes has it?	One—Then it belongs to	II.
	Two or more—Then it belongs to . .	III.

Or,

If the seed cannot be found, the stem or the leaves must furnish answers to the following questions:—

1. Are there any sap and pulp vessels?	No.—Then it belongs to Division	I.
	Yes.—Then see question 2.	

2. Is the stem tapering upwards, covered with bark, and the wood softer on the exterior than in the interior? } No.—Then it belongs to I.
Yes.—Then it belongs to III.

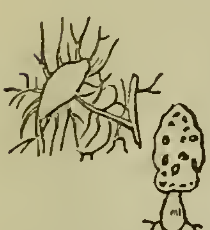
De Candolle, I may mention, terms the first class cellular[1], because the plants have cells but no vessels, and the two others vascular[2], because they have both vessels and cells. The vascular plants he again divides into ingrowing[3], and outgrowing[4].

Second Lesson on Jussieu's System.

These three great divisions having been mastered, the beginner may then look into the fifteen classes and their orders.

I. *Plants without Seed-lobes or Sap and Pulp Vessels*[5].

FIRST CLASS[5].



The seed when it can be discovered is simple and without parts. There are ten orders: 1, Sea-weeds; 2, Mushrooms; 3, Lichens; 4, Liverworts; 5, Mosses; 6, Lycopodiums; 7, Ferns; 8, Marsileas; 9, Mares' tails; 10, Starworts.

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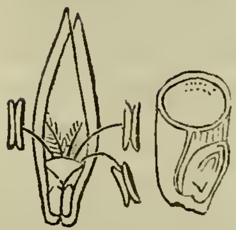
(1) In Latin, *Cellulares*. (2) In Latin, *Vasculares*.
(3) In Latin, *Endogenæ*. (4) In Latin, *Exogenæ*.
(5) In Latin, *Acotyledones*.

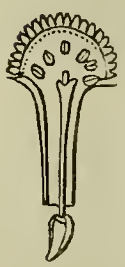
II. *Seeds with one Seed-lobe; Plants with Sap and Pulp Vessels*[1].

SECOND CLASS[2].



Flowers with the stamens inserted under the seed organ. There are seven orders: 1, Pond-weeds; 2, Arums; 3, Burreeds; 4, Saururi; 5, American water plantains; 6, Bog-rushes; 7, Grasses.

THIRD CLASS[3].



Flowers with the stamens inserted around the seed organ. There are ten orders: 1, Palms; 2, Restios; 3, Rushes; 4, Cammelinas; 5, Pontederias; 6, Water Plantains; 7, Meadow Saffrons; 8, Asparagus; 9, Lilies; 10, Bromelias.

FOURTH CLASS[4].

Flowers with the stamens inserted above the seed organ. There are ten orders: 1, Black Bryonies; 2, Daffodils; 3, Irises; 4, Hœmodori; 5, Musas; 6, Gingers; 7, Orchises; 8, Frogbits; 9, Water Lilies; 10, Balanophoras.

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(1) In Latin, *Monocotyledones.* (2) In Latin, *Monohypogyneæ.*
(3) In Latin, *Monoperigyneæ.* (4) In Latin, *Monoepigyneæ.*

III. *Seeds with two or more Seed-lobes* [1].

1. *Without Petals* [2].

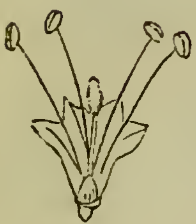
FIFTH CLASS [3].

Flowers with the stamens inserted above the seed-organ. There are three orders: 1, Asarabaccas; 2, Cytini; 3, Santali.

SIXTH CLASS [4].

Flowers with the stamens inserted around the seed-organ. There are seven orders: 1, Eleagni; 2, Lace Woods; 3, Proteas; 4, Laurels; 5, Nutmegs; 6, Polygonums; 7, Beets.

SEVENTH CLASS [5].



Flowers with the stamens inserted below the seed-organ. There are two orders: 1, Amaranths; 2, Marvel of Peru.

(1) In Latin, *Dicotyledones*. (2) In Latin, *Apetalæ*.
(3) In Latin, *Epistamineæ*. (4) In Latin, *Peristamineæ*.
(5) In Latin, *Hypostamineæ*.

2. *With one petaled blossoms*[1].

EIGHTH CLASS[2].

Flowers with the petal inserted below the seed-organ. There are twenty-one orders:—1, Plantains; 2, Thrifts; 3, Primroses; 4, Lenticularias; 5, Globularias; 6, Speedwells; 7, Night Shades; 8, Acanthuses; 9, Jasmins; 10, Vervains; 11, Myoporinias; 12, Labiate flowers; 13, Borages; 14, Convolvuli; 15, Lungworts; 16 Bignonias; 17, Gentians; 18, Periwinkles; 19, Milk trees; 20, Myrsinias; 21, Ebenaceas.

NINTH CLASS[3].

Flowers with the petal inserted around the seed-organ. There are four orders:—1, Styraces; 2, Heaths; 3, Gesnerias; 4, Bell flowers.

TENTH CLASS[4].

Flowers with the petal inserted above the seed-organ, and the anthers united. There are two orders:—1, Chicories; 2, Boopidias.

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(1) In Latin, *Monopetalæ*. (2) In Latin, *Hypocorolleæ*.
(3) In Latin, *Pericorolleæ*.
(4) In Latin, *Epicorolleæ Synanthereæ*.

ELEVENTH CLASS [1].

Flowers with the petal inserted above the seed-organ, and the anthers not united. There are five orders:—1, Teazles; 2, Valerians; 3, Whirlworts; 4, Wood-bines; 5, Misseltoes.

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3. *With many petaled blossoms* [2].

TWELFTH CLASS [3].

Flowers with the stamens inserted above the seed-organ. There are three orders: 1, Rhizophoras; 2, Umbelled plants; 3, Ginsengs.

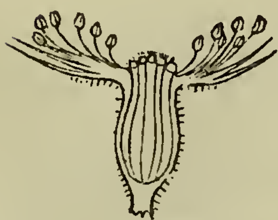
THIRTEENTH CLASS [4].

Flowers with the stamens inserted below the seed-organ. There are thirty-nine orders:—1, Ranunculi; 2, Dillenias; 3, Anonas; 4, Barberries; 5, Calumbas; 6, Ochnas; 7, Rues; 8, Pittospori; 9, Geraniums; 10, Mallows; 11, Banians; 12, Cocoas; 13, Chlenaceas; 14, Lime trees; 15, Tea trees; 16, Olaxes; 17, Marcgraavias; 18, Gamboges; 19, St. John's Worts; 20, Orange trees;

(1) In Latin, *Epicorolleæ Corisanthereæ.*
(2) In Latin, *Polypetaleæ.* (3) In Latin, *Epipetaleæ.*
(4) In Latin, *Hypopetaleæ.*

21, Vines; 22, Maples; 23, Horse-chestnut trees; 24, Sethias; 25, Canellas; 26, Soap-berry trees; 27, Milk worts; 28, Tremandreas; 29, Fumitories; 30, Poppies; 31, Cross worts; 32, Cappares; 33, Woads, 34, Flacourtias; 35, Sun flowers; 36, Sundews; 37, Violets; 38, Frankenias; 39, Pinks.

FOURTEENTH CLASS[1].



Flowers with the stamens inserted around the seed-organ. There are twenty-six orders:—1, Rupture worts; 2, Spring chickweeds; 3, Mesembryanthemums; 4, Saxifrages; 5, Hamameles; 6, Brunias; 7, Stonecrops; 8, Cactuses; 9, Gooseberry trees; 10, Gourds; 11, Loasas; 12, Passion flowers; 13, Thousand leaf; 14, Tree primroses; 15, Combretums; 16, Myrtles; 17, Melastomas; 18, Marsh hyssops; 19, Roses; 20, Homaliums; 21, Samydas; 22, Peas; 23, Turpentines; 24, Buckthorns; 25, Spindle trees; 26, Holm oaks.

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4. *With the Stamens and Pistils in separate Flowers.*

FIFTEENTH CLASS[2].

Flowers without petals. There are eight orders:—1, Spurges; 2, Nettles; 3, Monimias; 4, Willows; 5, Gales; 6, Oaks; 7, Birches; 8, Pines; 9, Sago Plants.

(1) In Latin, *Peripetuleæ*. (2) In Latin, *Declineæ*.

OBJECTIONS TO THE NATURAL SYSTEM.

We are told, by those who boast of this as the *Natural System*, that it brings together the plants which most resemble one another in anatomical structure, in what are called affinities, and in nutritious or noxious qualities. To show that I do not exaggerate a jot in this statement, I refer the reader to Loudon's Encyclopædia of Plants, p. 1052, where we are told, in the portion of the work contributed by Professor Lindley, that when the natural order of a plant is ascertained, many of its most important qualities, such as " medicinal properties," may be " safely" inferred. Now, if this were so, nobody, I think, would dispute the high value of this *Natural* system. Unfortunately, however, this principle is virtually contradicted by what follows. Thus, under Cellulares, Order viii., Mr. Lindley gives us "*Cetraria Islandica*, &c., tonic and nutritive," along with, " *Evernia vulpina*, poisonous." Under Vasculares, again, Order cxli., (to say nothing as to size, form, and structure,) " the fig, the mulberry, and the bread-fruit tree" are *naturally* (common sense would say unnaturally) classed " among worthless weeds," such as " the common stinging nettle," "and shabby half herbaceous shrubs," such as "the hemp and the hop;" but what are we to think of " safely" inferring from the fig, the bread-fruit tree, and the sago plant, the " medicinal properties" of " the Upas tree, now known to be the *Antiaris toxicaria*, the inspissated juice of which," to use Mr. Lindley's own words, "is a frightful poison" (p. 1083)? Were I the proprietor of this work, I would not hesitate an instant to break up the stereotype plates, in order to expunge such glaring contradictions and highly dangerous errors. In his own work on the "*Natural System*," Mr. Lindley alludes to the discrepancy in these words:—

"The fig, the bread-fruit tree, the jack, and the mulberry, are all found here, and are a curious instance of wholesome or harmless plants in an order which contains the most deadly poison in the world, the Upas of Java; the juice, however, of even those which have wholesome fruit, is acrid and suspicious, and in a species of fig, *Ficus toxicaria*, is absolutely venomous [1]." Now had the author not been blindly prejudiced in favour of the system, he must have seen, that instead of this being a "curious instance" authorising a theoretical suspicion of the mild fig and nutritious bread-fruit, it is fatal to the whole doctrine of safely inferring medicinal properties. Mr. Lindley complains bitterly in his preface, that "the *Natural System* of Botany" "has to contend with a great deal of deeply-rooted prejudice;" but the wonder ought rather to be, that such doctrines as those under notice ever found any person so fool-hardy as to promulgate and defend them.

In the division just alluded to, which is the fifteenth class of our ALPHABET, in the second order, among those especially called the *true* nettles (as if there

(1) P. 95. Introd. Nat. System of Botany.

could be in nature any false ones), we find the mulberry tree side by side with the stiff hemp and the light climbing hop. Now admitting that the seed and the flowers of all these agree in structure, as they nearly do, it must appear obvious that the plants are as incongruously and unnaturally grouped as possible, in reference to their general form and habits; while if we look to qualities, what can be more incongruous than to rank the poisonous upas of Java in the same order with the fig? In the seventh order of the eighth class, also, we find the wholesome potato and the mild shepherd's club ranking with henbane and the deadly nightshade. In the third order of the eleventh class, we find not only lofty trees ranked with dwarf shrubs, and tiny slender herbs; but we have the coffee ranked with the well known emetic, ipecacuana, and this again with Peruvian bark. In the thirteenth class, we have, so far as size and form are concerned, the low growing pinks, violets, and buttercups, ranked not only with the tall sun-flower, but with the stately horse chestnut, the lime tree, and the maple; and these again with the climbing vine, and the waving barberry shrub; while we could not, I think, "safely" infer the "medicinal properties" of the poppy, from which opium and laudanum are procured, gamboge, which is violently purgative, and buttercup, which is an acrid poison, from the mild cocoa and marshmallow, and the wholesome orange. This would indeed be altogether preposterous. The fourteenth class furnishes precisely similar discrepancies. In point of size and form, we find the spring chickweed, one of our smallest British plants, ranked among apple trees and holm oaks; and these again with the light climbing passion flower, and gooseberry bushes. The "medicinal properties," however, of the poisonous elaterium, the acrid stonecrop, the emetic laburnum, and the purgative buckthorn, could not be "safely" inferred from the nutritive pea and bean, or the wholesome pear, apple, and gooseberry,—which are all in this class.

I could readily fill a volume with the similar discrepancies of this so preposterously belauded *Natural System,* which, if it have not to answer for the loss of human lives by poisoning upon principle, it is no fault of its promulgators. The fact is, that so far from being more natural than the Linnæan system, these instances, now given, with many more, show it to be more palpably unnatural. But the day of philosophy has now, as I fondly hope, at last dawned, and rational and useful studies must ultimately banish mystery and nonsense, though these may, for a season, stalk about in the mask and under the assumed names of philosophy and science.

INDEX

OF TECHNICAL TERMS IN THE NOTES.

THE END.

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